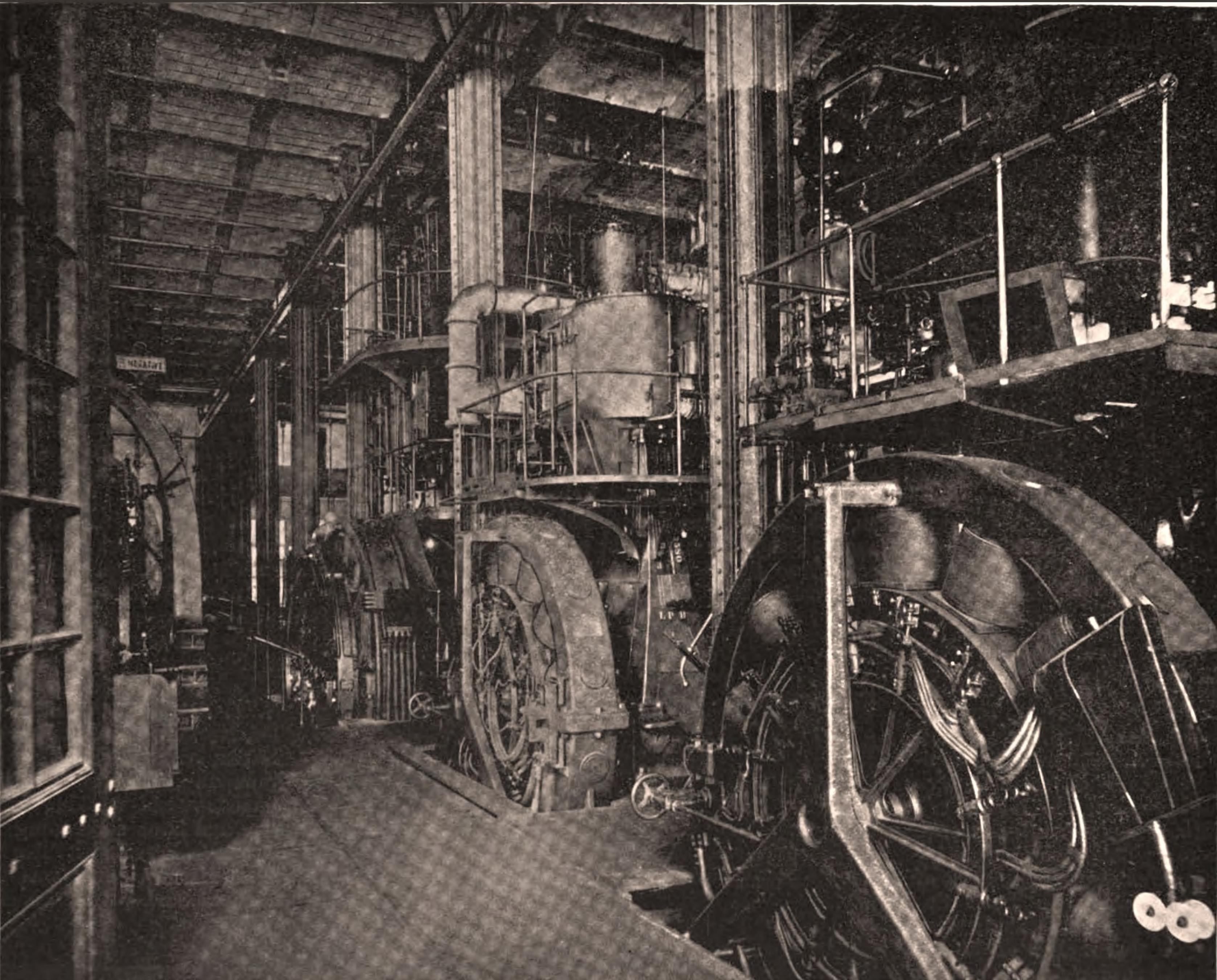
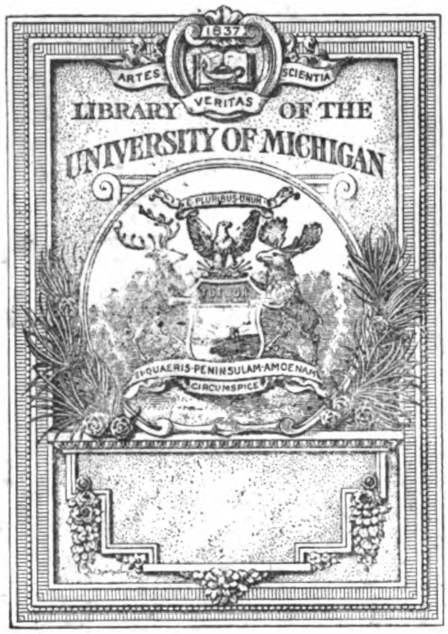


Electrical engineer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THE ELECTRICIAN.

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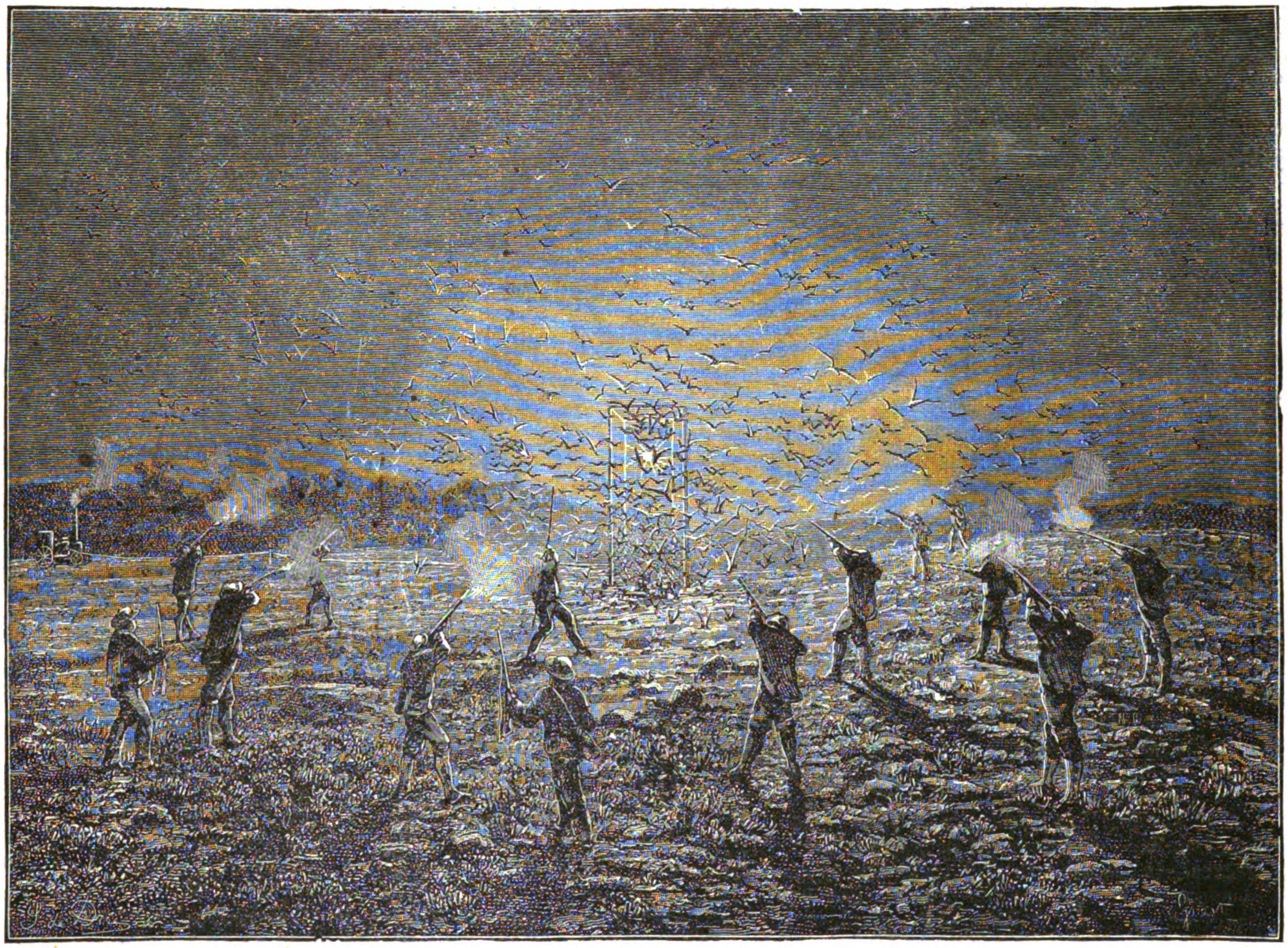
ELECTRIC LIGHTING AND SHOOTING.

READERS of manuals of shooting, must well remember the scenes of night shooting, or the midnight spearing of salmon, as portrayed in Scott's Rob Roy. Shooting manuals, of course, give sapient advices as to the dangers that men, unprovided with flannels, and on the shady side of forty, must necessarily encounter. We are not partisans of the unnecessary slaughter of the beautiful tenants of the air, exterminating the comparatively small number of the denizens of air that still remain.

These electric shooting parties, have excited great indignation, even in England, where young ladies find a pleasure in hunting the timid hare to death, and bagging the fox, which, (vermin though he be,) seems to have been created for some purpose unknown to us.

Electricity need not be made an adjunct to so-called sport.

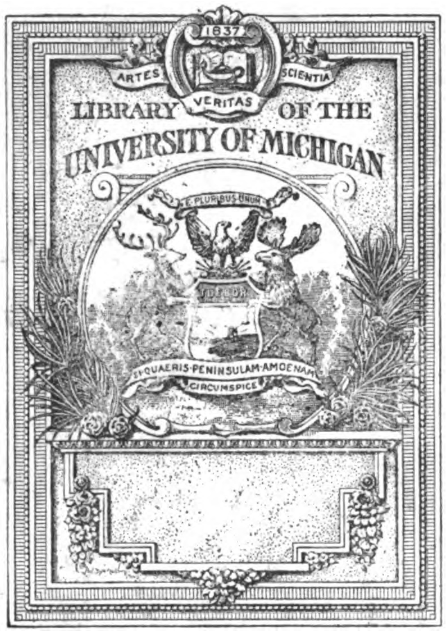


SPORTING BY ELECTRIC LIGHT.

of the cruel hunting of a few of the declassés of God's creatures; and, although, we have before our eyes, a very striking picture of electricity applied to what is the French idea of sport—a *battue*, we are confidently of the opinion, that the good sense of our people, in default of Mr. Bergh's exertions, will never require the application of electricity in

THE PROSCH TELEGRAPH KEY.

TELEGRAPH keys, distinguished from the form so long in use by new and obviously advantageous features, have rapidly multiplied within the last few years. A light, elastic lever replaces the old, heavy, rigid lever. Solid trunnions replace shaky trunnions, or a peculiar joint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THE

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A Weekly Review

OF

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(January to June.)

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Vol. XXI. JANUARY 1, 1896 No. 400.

ELECTRIC LIGHTING.

THE MISTAKEN IDEAL OF ARTIFICIAL LIGHT IMPROVERS.

BY DR. W. H. BIRCHMORE.

IT seems strange to one, who has made it his business to study and collate the results of other men's labor and experience, to see how, from time to time, some one will point the way by which a much-desired result is to be arrived at, or a given improvement in a manufactured article made, and yet how steadfastly the very men who point the way will persistently follow some other path, which they in many instances complacently warn their fellow-workers is not the right one. The last instance of this sort of thing which has passed under my notice is contained in the work entitled, "Industrial Photometry," by Palaz, p. 17:

"Finally O. E. Meyer (*Monatber. der Berliner Akad.*, 1880,) obtained the following values, taking the rays emitted by a gas flame as a standard, and making the intensities corresponding to the *D*-line unity.

Rays of the Spectrum.	*B* (Orange.)	*D* (Yellow.)	*E* (Green.)	*G* (Violet.)
Petroleum lamp.......(1)	0.66	1.00	1.40	1.00
Sunlight, direct.......(2)	4.07	1.00	0.48	0.15
Sunlight, diffused.....(3)	1.25	1.00	0.50	0.41
Voltaic arc.......... .(4)	1.10	1.00	0.40	0.10
Incandescent lamp....(5)	0.80	1.00	1.40	1.10

The above results are sufficient to allow of the classification of sources of light according to the nature of the light which they emit."

The above quoted passage gives one of the most inter-

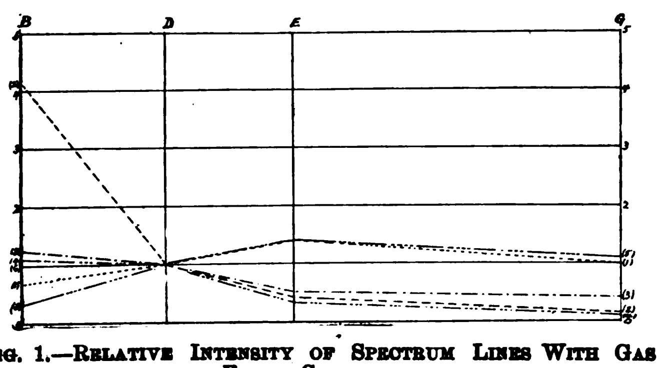


FIG. 1.—RELATIVE INTENSITY OF SPECTRUM LINES WITH GAS FLAME STANDARD.

esting contributions of the book in regard to the matter at issue, and is worthy of an extended discussion in a way which Palaz did not choose to use the figures therein contained. The process by which the figures were reached seems to have been much as follows: The rays in the neighborhood of the *D*-line were rendered equal by the arrangement of the sources of emission, and then the relative amount of the rays at each of the other lines measured, using the amount emitted by the gas flame as unity. There are at least a half-dozen ways in which this can be done, and the one employed is indifferent, in the result, so long as the work is well done.

In discussing these figures it must be remembered, that no matter how accurate they were for the time and place of making, they cannot be verified at will, because the light of one day is hard to adjust with the light of another; but they may justly be taken as representing exactly the conditions of the experiments of which they are the record. It is then only needful to put them into

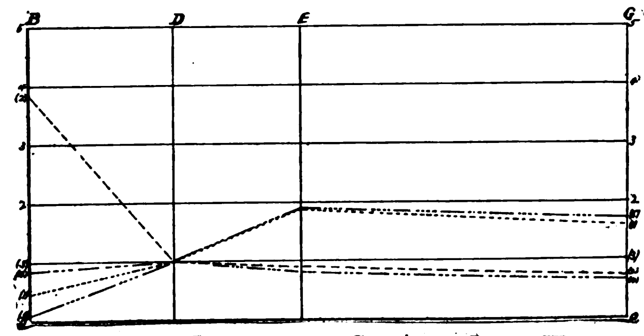


FIG. 2.—RELATIVE INTENSITY OF SPECTRUM LINES WITH SUNLIGHT STANDARD.

a shape where their significance becomes obvious. This I have done by constructing the accompanying diagrams.

In Fig. 1, the gas flame light is used as the standard; in the Fig. 2, the "Diffused Sunlight" (daylight), is employed in the same capacity. The lines *b*, *d*, *e*, and *g*, are spaced as in the Sun spectrum. By examining these diagrams it appears that at the time of the experiments the direct sunlight (2) contained rather more than fourteen times as much red for the same amount of yellow as the incandescent lamp light had; (5) is the curve of the incandescent lamp light; (3) represents the curve of "daylight," and (4) that of the arc; (1) is that of the petroleum lamp. (6) represents the curve of the gas flame, and as it is the standard it is represented by a straight line.

Examination of these curves in Fig. 1, makes it clear that with the standard chosen, the rest of the lights divide into two parts: on the one hand, the petroleum and the incandescent electric lamp, containing a larger proportion of blue, green and violet; and on the other the arc lamp, and both sunlight and daylight, which contains less of these rays than does the incandescent flame. This excess of violet light plays a very important part in the "eye strain" to which so much of the "neuralgia" of women, and the headache and worry of men are due.

Fig. 2 emphasizes the same fact. It is clear that every one of the sources of light examined contains more of the blue, green and violet than does the diffused sunlight, except the "arc" light; which comes nearer the proportion of direct sunlight. It is also made clear that even diffused daylight contains more than eight times as much red for the same amount of yellow, as does the incandescent electric lamp, that is, the carbon filament,

These diagrams have a direct bearing on the phenomena known as the maximum stimulus, and also offer an explanation of its raison d'être. Although the definition of the phenomenon is well known, the phenomenon itself has always been an indeterminate quantity in all photometric experiments, and a very serious difficulty in the solution of illumination problems. In order that my definition may not be caviled at, I quote that of Palaz: "The maximum stimulus is the superior limit, above which an increase in the intensity of the stimulus produces no increase in the intensity of the sensation." My object in this discussion is to make clear, if I can, how a purely physiological factor is at the bottom of the present difficulty with our lamps and to show that it is not in the dicta of a Bunsen photometer that we must find our standards but in the brightness of certain colors, and in the "spectra of reflection."

A series of experiments covering a number of individuals makes it apparent that this maximum stimulus varies not with the amount of light at large, but with the amount of light of particular kinds. If an apparatus be used, constructed for the purpose, including a differential photometer of some sort, and a pupilometer, it can be shown that the number of rays of a monochromatie light in the neighborhood of B-line required to produce a given contraction of the pupil is twenty-five times as great as the amount required from the neighborhood of the G-line to produce the same contraction. It thus becomes a matter of the first importance to determine the relative proportion of the various kinds of light in the rays sent out by the illuminants which are the subject of our inquiry.

Expressed in percentages the relative proportions of the various rays in these illuminants, using these same figures of Meyer, appear as follows:

Percentage Composition.

Ray of the Spectrum.	B (Orange.)	D (Yellow.)	E (Green.)	G (Violet.)
Petroleum lamp........(1)	16.2	24.6	34.5	24.6
Sunlight, direct........(2)	72.0	17.7	7.6	2.7
Sunlight, diffused......(3)	39.5	31.6	15.9	13.0
Voltaic arc............(4)	42.3	33.5	15.3	8.9
Incandescent lamp.....(5)	8.0	26.3	36.8	28.9

Bearing in mind that for thousands of years the pupil has been protecting the eye from direct sunlight, and that it has only recently been called upon to protect it against violet light, the above figures are particularly significant, as they show that the pupil would contract nearly or quite as fast for the B-line rays of the "direct sunlight" as it would for the G-line rays. $72.0 \div 2.7 = 26.6$. This shows that on a very bright day, sunshine, the size of the pupil, and consequently of the light pencil, *i. e.*, the total light received by the eye, is limited by the red or orange rays. In other words, on a bright day out of doors, we do our "seeing" with the impressions produced by red and yellow rays.

Studies made on the "Plains," in Algiers, and in the Northern part of Russia appear to indicate that the various observers found the light of a sunshine-day of about the same centesimal composition everywhere. It is a rather difficult matter to compare and adjust the results, for among so many different methods and observers there were of necessity differences in instruments, instrumentation and in personal equation of which no one holds the clue; still it seems that under the same condition of the "rain band" the amount of light of the various kinds is much the same all over the world, unless it is varied by some special local cause; for example, in New York there is a strictly local rain band nearly all the time.

If the direct sunlight, of Meyer, is translated to mean the light of a bright, dry day, and it agrees surprisingly well with all the data of such days, we may with equal justice translate his diffused daylight to mean the daylight of a cloudy day; on this basis also some most astonishing coincidences with the results of the labor of others are to be obtained.

In the first place it is seen that the opinion of landscape painters that a day of this sort should be called a gray day is very well founded; the tints of all sorts have a tone that it is hard to account for, and objects appear dim. These facts are due to two unlike causes, first to the color of the incident light, and the spectra of reflection which it produces; and second to the fact that the eye refuses the light, and makes small use of what there is of it.

Pupil measures show that if monochromatic orange light is dimmed the pupil expands at the same rate, admitting the same amount of light at all times; they also show that if the light of a very bright day is dimmed by decreasing the aperture through which it comes, the results on the pupil are absolutely identical; therefore, if a gray day were simply a day of less light, the pupil would expand, the aperture through which the light reached the eye would increase in area, and as the same amount of light would be admitted, the sensation of light and shade, and the impressions of color, would be identically the same at all times. This is not at all what happens; the pupil is usually smaller on a gray day than it is on a bright one, thus showing that the amount of light which enters the eye is actually less. Less not only as to the rays which the clouds shut out; but also by a larger number which the eye mechanism itself excludes, for some reason which is an automatic stimulus to such exclusion.

The statements of Meyer give the reason for such exclusion, and give it plainly; it is the influence of the G-line rays; the eye finds itself overpowered by these rays and shuts its diaphragm and excludes the total light until the amount of the G-line rays admitted is made equal to the amount of the same rays admitted in the sunshine. Referring now to the table of the percentage composition of the lights, we find that for every hundred violet rays admitted, the eye admits as follows:

Ray of the Spectrum.	B	D	E	G	Total.
Sunlight, direct (2)..........	2664	656	281	100	3701
Sunlight, diffused (3)........	731	585	294	100	1710

Consequently the absolute number of rays of light which enter the pupil on a gray day is less than half of the number of those which enter on a bright one. This is on the assumption that the owner of the eye is simply looking "into the void of heaven." If he is trying to do anything else, except read a carefully selected ink imprinted on a carefully selected paper, the eye will not even receive this half of the rays to which it is accustomed, for while the diffused light controls the size of the pupil to the greatest degree, the light which is reflected from the object at which the owner looks determines the spectrum of reflection, and therefore those sensations of contrast by which form and color are made evident to the mind. Applying the same method to the "incandescent electric lamp" the following result is reached:

Rays of the Spectrum.	B	D	E	G	Total.
Incandescent lamp (5)......	21	92	137	100	340
Petroleum light (1)..........	85	100	138	100	423

This shows that for the same number of violet rays the sun-light has 10 times as many luminous rays as the incandescent electric light, and nearly 125 times as many red; yet the aperture of the pupil will be the same size for the 340 rays of the incandescent lamp as for the 3701 of the sun-light.

This shows that both of these lights are rich in violet

rays; gas light which used to be rich in red rays is now losing them in the race for white light and has become as rich in violet as the petroleum, although still richer in red; and therefore in both the incandescent lamp, and in petroleum lamps of all sorts, the total number of light rays that can be utilized is very small, simply because they are already too rich in violet light.

These facts are still more complicated, and the fitness of the present ideal of the lamp improvers is still further impeached by the fact that lamps are not intended to be looked at, but to see things by; that is to say, to have their light absorbed and reflected in various ways by the objects about them, and thus to make the eye sensible to their presence by sensations of form and color. Without going into the details of the spectra of reflection, it may be well to state that more than one-half of all the objects in this world are made visible to us by the reflection from their surfaces of rays between the *B*-line and the *D*. Consequently the objects seen by the incandescent lamp are objects seen on a very gray day indeed.

All this has nothing to do with the candle power of the lights as measured on a Bunsen photometer, or with any apparatus which obtains a comparison in this way, but depends on the physical relation between the stimulus and the physiological reaction which it produces.

There is no announcement of new facts in all this; the men who are studying the act of vision and its relation to the improvement of artificial lighting have been pointing to these relations between light and seeing since 1882, and it does seem hard that those who write books and give the impulse to so much of human labor will not attend to them. Even Palaz, who of all men ought to know better, sets up the light of the glow worm as the ideal to which the lamp men should work; yet if he had stopped to think, he would have remembered that even if he could make a light of any desired intensity in this way, the eyes of the largest part of mankind would quickly decide the question and declare that after all it was only a makeshift for the sunshine and a poor makeshift at that.

The true ideal of the lamp men is not the glow worm but the sunshine, and if they expect to get sunshine without heat, let them; but it is doubtful if the world would agree that it was a good thing if they did; they would find it only moonshine after all their trouble. Just as long as 75 per cent. of the reflected visual intensity of the sunlight is longer in its waves than *D*, and it will be so probably for some time yet, it would be better policy on the part of those interested in improving lamps to adopt it as their ideal, rather than try to attain one to which they must educate the light sense of mankind: a task from which the most enthusiastic of the believers in the public school system would shrink, if he were able to understand the meaning of his ambition.

PRICE RESTRICTIONS AT LANSDOWNE, PA.

The Lansdowne electric light ordinance contains a number of restrictive provisions in regard to price, not only for street lighting, but also for private dwellings. Where 100 lamps or over are installed, the price is not to exceed $2.50 per annum; where less than 15 lamps are used the price is not to exceed $3.50 per lamp. If the householder prefers to pay for actual consumption, the price is not to exceed three-quarters of a cent per lamp per hour. Twenty-five candle power incandescent street lamps are to be furnished for $12 per year each.

THE BRAINERD MUNICIPAL PLANT SOLD.

The vote on the proposition for the city of Brainerd, Minn., to sell its electric light plant to C. N. Parker, of that city, and E. C. and P. A. Gibson, of New York, resulted in a vote of 723 in favor of the proposition to 142 against. Ten thousand dollars will be expended for improvements on the plant at once.

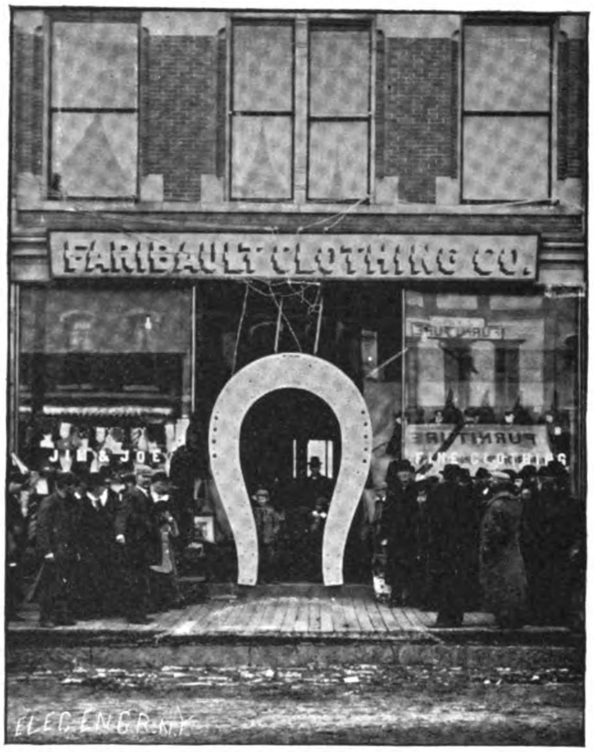
SOME FEATURES IN THE STANDARD SOCKET DISCUSSION.

BY GEORGE T. HEWES,

Gen. Man. Faribault, Minn. Consol. Gas and Elec. Co.

FOR the same reason that individual central stations adhere to some particular style of socket for a "standard" in their work, it is as quite essential, that a "standard" socket for universal use be procured. Without entering into a discussion of the special advantage or disadvantage of the many sockets on the market, the writer desires to advocate the Thomson-Houston socket as the most advantageous in its simplicity for connecting up, its immunity from short circuit, etc.; while for temporary illumination purposes a kindred substitute can be easily and cheaply constructed.

Recently, upon short notice, the writer had occasion to



A SPECIAL STREET ILLUMINATION SIGN BUILT FOR USE AT FARIBAULT, MINN.

devise a street illumination for one thousand lamps, extending along the side of the public streets in Faribault. He procured one hundred strips of elm, 2½ inches wide, ½ inch thick and dressed on both sides. On each side was stapled one length of bare copper wire, No. 10 B. & S., and ten machine screws, connected with the underneath wire, projected through the wood the required distance from the upper wire, thereby improvising a perfect keyless Thomson-Houston socket. These strips can at any future time be bent in many symmetrical shapes by first immersing in water for a few hours. Imagine, the cheap advertising sign which can thus be constructed! Not one of the thousand lamps failed to glow; nor were they in the least affected by an unexpected rain storm.

The cost of one thousand sockets would have been in the neighborhood of $150, without estimating the expense of labor for connecting; and the additional expense of insulated wire would have made the expense prohibitory. Yet, the insulation between the bare wires was perfect for all practical purposes, and the expense for the screws was

but $5.00. The illustration of the horseshoe shows what can be done with one hundred lamps at an expense of fifty cents for sockets.

What other socket can be so cheaply imitated with the same satisfactory results? Is it not time the central station manager first looked to his own interests, and did not allow manufacturers to settle the question of "standardizing" a socket to his disadvantage?

THE BENNETT BISULPHIDE OF CARBON ENGINE.

BY LUCIUS T. STANLEY.

MANY have been the attempts to employ as the working fluid in the steam engine vapors other than steam, derived from liquids having vapors of higher expansive force at a given temperature. Among these, bisulphide of carbon and ammonia have been favorites among inventors, and the most recent attempt in this field is the engine arrangement devised by Mr. J. R. Bennett, of Philadelphia.

It may be remarked, that in the many attempts that have in the past been made in this direction, two radical conditions—either or both conducive to failure—have presented themselves, and these are:

First, inability to maintain a constant pressure of the chemical vapor; and, second, inability to properly lubricate the cylinder and its working parts against the high temperature incidentally developed. This second condition has probably been generally misunderstood. Because the working parts of the engine which were in direct contact with the vapor soon became roughened and furrowed, it was believed that the vapor had a destructive effect upon the metal. It is claimed that Mr. Bennett's experiments have not only disproved this theory, but have demonstrated that bi-sulphide of carbon at least is a cleanser and preservative of iron and steel. There is reason for belief that these adverse conditions above noted have been overcome in the system now under consideration.

In the accompanying diagram the salient features only of the system are shown; details of the water supply and of the device for primarily charging the generator, etc., being omitted in order to avoid confusion.

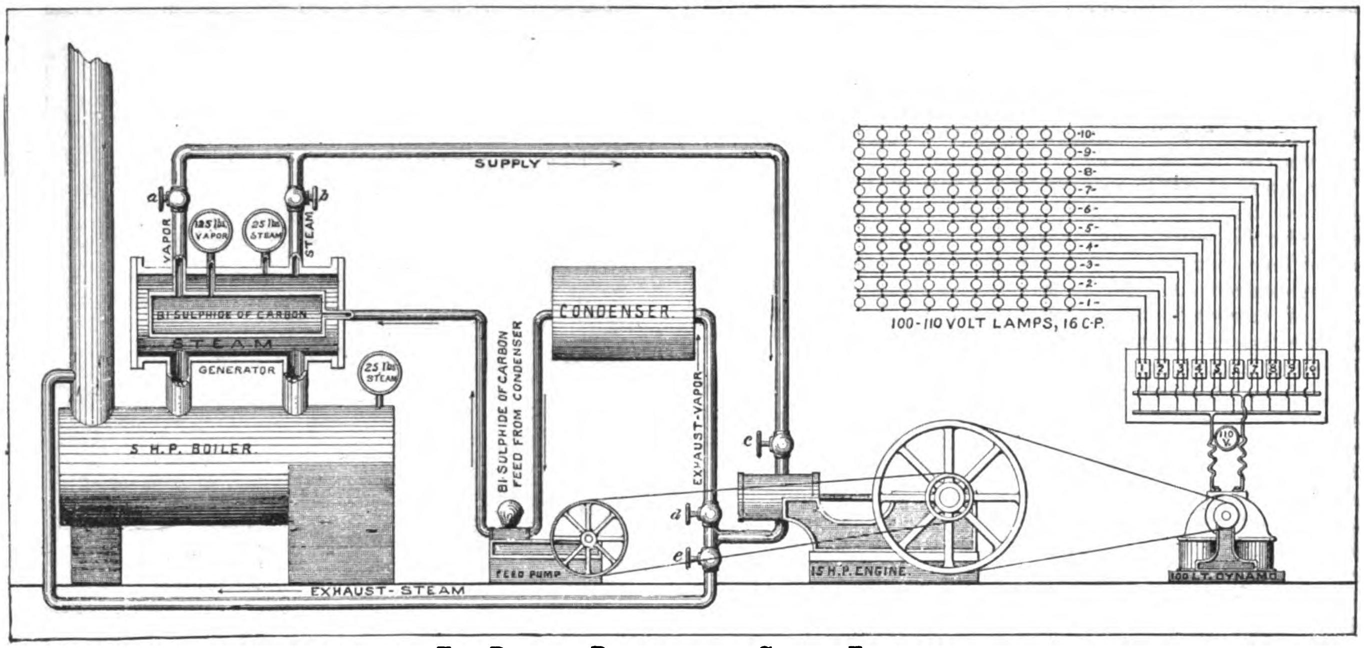
For the purpose of comparing the power derived from steam direct, and that derived from chemical vapor generated by the same steam, both the steam boiler and the vapor generator are connected to the engine by a common supply pipe through valves *a* and *b* which are conveniently arranged for alternate connection to supply. In practice there would be only the connection between the generator and the engine, the steam boiler acting solely as a heater.

The boiler is of the common tubular horizontal type, upon the top of which is set the "generator," composed of a steam drum within which is the cylindrical receptacle for the bi-sulphide. Supply connections to the engine are made in the conventional manner. The vapor exhausts into the condenser, which is the common arrangement of a worm or coil surrounded by a water jacket. In this plant the condensed exhaust is pumped from the condenser into the generator, but in practice, it will be trapped from the condenser into the generator. The steam exhausts directly into the chimney.

The engine is an Armington & Sims, of 15 H. P. The dynamo is compound wound and of 100 lights capacity at 110 volts. The lamps are of 16 C. P., 100 in number and arranged in 10 branch circuits of 10 lamps each; each branch being controlled by an individual switch.

When the steam gauge showed a pressure of 25 lbs., valves *b*, *c* and *e* were opened and the engine started. In a short time, the voltmeter showing a pressure of 110 volts, switch No. 1 was closed and branch circuit No. 1 was lighted, giving full glow. Throwing in circuit No. 2 caused both circuits to glow at about one half power and there was a corresponding drop in voltage, thus demonstrating that 25 lbs. of direct steam was capable of performing work to the extent of about 1 H. P. only. In the meantime the bi-sulphide of carbon, with which the generator had been primarily charged, had been heating, and the pointer of the vapor gauge began to move gradually until it finally registered 125 lbs., when valves *b* and *e* were closed, valves *a*, *c* and *d* opened and the feed pumps started. At once the engine responded to the increased pressure (the transformation from steam to vapor taking less than one minute) by increasing its speed, and one after the other the branch circuits were thrown in until six were glowing with full power, the voltmeter steadily indicating 110 volts pressure. By throwing in the seventh branch circuit, the glow was slightly dimmed and there was a slight drop in voltage.

Upon being asked if this was the limit to the power to be derived from the 125 lbs. pressure, Mr. Bennett explained



THE BENNETT BISULPHIDE OF CARBON ENGINE.

that, the engine being simply bolted to the floor, and having no solid foundation, it was the limit of safe running for any prolonged period. However, in order to show that it was not the limit of power, he opened the throttle *d* a little more, when two more branch circuits, making eight in all, were thrown in, and the 80 lamps glowed with full power, the voltmeter holding steadily at 110 volts. This was for a couple of minutes only, as the engine and room were in a tremor, and the supply was again throttled until the six branch circuits only were in circuit. Here it was held.

The writer remained for perhaps an hour longer, and during that period the pointer of the vapor gauge remained at 125 lbs. as if it were fixed there; the voltage remained steadfast at 110, the 60 lamps glowing at full power. There was no undue heating of the cylinder or its working parts, and during this entire period the steam gauge recorded a steady pressure of 25 lbs.

Apparently there was nothing to prevent an indefinite continuance of these conditions, so long as coal was kept burning in the fire box.

The plan for maintaining constant pressure at the generator gauge is based upon the principle of the circulating steam or hot water heater. After heating the water to the point of evaporation for a desired pressure, all heat energy beyond that necessary for this purpose is carried along with the steam, or with the water as it may be, as heat instead of being used to increase the pressure, heat alone being needed in the outside shell of the generator.

The lubricating medium for the cylinder and its parts is a compound; the basic ingredient being a substance that has no affinity for any of the chemicals that may be used for this purpose, and which, moreover, is practically unchanged by any degree of heat possible to be generated in the cylinder. Its application is novel and apparently efficient, and it probably has a value in direct steam practice at extreme pressures.

This system is being introduced by The Giant Power Company, composed of business men of the highest standing in Philadelphia. This company now has in hand the erection of a plant of 100 H. P. capacity which is expected to be ready for inspection early during the present year.

The plant above described is at 145 North 7th street, Philadelphia.

MUNICIPAL SOCIALISM AT DETROIT, MICH.

The proposal that the public lighting plant shall embark in the business of furnishing light to private consumers as well as to the public buildings is one, says the *Detroit Free Press*, that calls for serious consideration before it is adopted. It is quite possible that under judicious management, if we could always rely on having such, light could be supplied at a lower rate than private concerns are charging; but it does not by any means follow that for this reason it would be wise to embark in such an enterprise. There are other things to be taken into consideration and chief among these is the commitment of the city to the socialism involved.

For if it is an argument in support of furnishing light to the private consumer from a public plant, that the latter can do it more cheaply than private concerns can, the argument is equally strong in regard to many articles of general consumption. It is much stronger indeed in respect to other things than it is in respect to electric light. That commodity, though now used to a considerable extent in the city, is largely a luxury. It is not in general use and would not be even at the price for which it could be furnished by the public lighting plant. The saving, if any, would benefit a comparatively small class and that composed of those who do not stand greatly in need of public assistance.

The *Free Press* then instances bread and shoes as things of far more vital interest to a large part of the public than electric light, and adds:—In point of fact, for reasons already given, the making of bread and shoes for the multitude in a public plant could be justified upon grounds which are wholly wanting in the electric lighting argument. In considering this matter we have for the argument's sake left wholly out of consideration the question whether the people would directly benefit for any great length of time. The public lighting which seems now so successful is, it should be remembered, an experiment. If it can be kept perfectly free from politics and managed with sole reference to furnishing the best possible light for the least money, it will continue to be a success. But what assurance have the people that it will so continue? The tendency, unfortunately, is away from that condition of things. The people do not need to be reminded that there has been for many months a drift toward the rendering of all commissions and departments subservient to the executive power and that an open effort has been made in more than one case to use that subserviency for personal and political aggrandizement. How much of that can the public lighting system or any other department of municipal business stand and continue to render good economical service? The question is not an easy one to answer; but it is important enough to suggest the propriety of going slow in regard to any extension of the principle involved in the public lighting system beyond the field of public service. As *The Free Press* has always insisted, it is an experiment to the making of which we were driven by an unhallowed "combine" among the electrical companies of the country; and time only can show whether it is on the whole a wise thing to do. Let us not complicate matters by overloading the experiment unless we are prepared to go the extreme length of municipal socialism hinted at in the illustrations we have offered.

WHERE THE INCANDESCENT LAMP IS UNKNOWN.

The most deplorable feature about the calamity at the mining town of Dayton, Tenn., is the fact, comments the *Pittsburgh Chronicle Telegraph*, that sixteen men lost their lives needlessly. They used the dangerous open lamps in their work, regardless of the record of death from such carelessness with which the history of coal mining is strewn. As long ago as 1815 Sir Humphrey Davy invented a lamp to prevent accidents in coal mines, founded on the principle that flame, in passing through iron wire meshes, loses so much of its heat as to leave it incapable of igniting inflammable gases. Yet at this late day there are mines employing scores of men, in which naked lights are used, ready to ignite explosive gases at any moment, and send the workmen into eternity. The company which operates the Dayton mines has decided that hereafter no open lamps will be allowed. This decision comes too late to be of any benefit to the sixteen men who are dead, and to the sixteen households which have been plunged into mourning. The calamity should be a warning to other mine-owners, and to other miners.

THE BEAUTIES OF STATE CONTROL IN TEXAS.

Superintendent Maddox of the city's electric light and water plant of Austin, Tex., reports that at Rusk penitentiary, where the pipe is made for supplying the city's system, the city's pipe inspectors report that out of sixty-four sections of the four-inch pipe examined forty-six were rejected, and out of sixty-four sections of six-inch pipe fifty-six were rejected.

THE WORCESTER ELECTRIC LIGHT CO.'S UNDERGROUND WORK.

Mr. H. H. Fairbanks, treasurer of the Worcester, Mass., Electric Light Co., writes us that the company have been building conduits of the National Conduit Co.'s cement lined type, which are intended to cover the business section of the city, especially that portion where overhead wires are a hindrance to the firemen in case of a fire. These conduits will contain all classes of wires representing the different services of the company—arc, alternating and power. The Worcester Co. has done this under no compulsion from the city, but considered it better policy, in spite of the large expense, to do it now rather than wait and be forced into it by the city authorities.

THE COSTLINESS OF THE LOGANSPORT, IND., MUNICIPAL PLANT.

THE allowances made by the council, upon the recommendation of the electric light committee, for repairs and maintenance, foot up over $1,500, which would mean an expenditure of something like $30,000 for the year. Unless the cost can be reduced, the expense of maintaining the plant and operating it is going to exceed the receipts. The complaint is made that the plant is already short of power, and that before the city can realize on its investment, much more powerful engines will have to be provided. The *Pharos* gets this information from a gentleman connected with the department.—*Logansport Pharos.*

"Enclosed please find draft for subscription to THE ELECTRICAL ENGINEER for 1896. Your motto must evidently be 'Advance,' for that accords with the impression conveyed by your paper during 1895."—HENRY G. STOTT, Buffalo.

MISCELLANEOUS.

ELECTROPLATING AND ELECTROTYPING IN THE UNITED STATES.

BY MARTIN BRUNOR.

BELOW I give a complete statement in regard to the extent of the electroplating industry in the United States drawn from the data in my possession. Owing to the increase in the use of new processes there has been a very material addition to the number of establishments, operatives, and electrical machinery. This statement does not include the electrotyping, etching, and jewelry trades, which, as is generally known, must use dynamos in connection with their product.

Establishments	392
Aggregate capital	$38,388,560
Value of plant	$2,226,482
Value of land	$167,817
Value of buildings	$142,362
Machinery, tools, &c., value of	$1,222,455
Live assets	$2,846,528
Miscellaneous expenses	$383,715
Average number of employees	2,708
Wages	$1,632,246
Officers, firm members and clerks, males, above sixteen years of age	600
Wages for above	$436,938
Officers, firm members and clerks, females, above fifteen years of age	190
Wages for the above	$6,471
Operatives, skilled and unskilled, males, above sixteen years of age	1,834
Wages for above	$805,628
Operatives, skilled and unskilled, females, above fifteen years of age	128
Wages for above	$192,000
Children operatives	103
Wages for above	$16,802
Piece-workers, male, over sixteen years of age	96
Wages for above	$48,125
Piece-workers, female, over fifteen years of age	24
Wages for above	$10,434
Cost of materials used, about	$1,256,000
Value of products, including receipts from custom work and repairing	$3,433,806

The approximate number of dynamos in use is 600, equalling a power of 60,000 amperes.

Since the publication of the *Practical Electroplater*, wherein I disclosed the process of removing the green from jewelry, a large number of the smaller jewelry establishments, employing from five men up, have introduced dynamos of a quarter to a half kilowatt, which is sufficient for their needs, the larger establishments using one to two kilowatt machines. The latter are comparatively few, as the quarter and half kilowatt machines are those most in use. As near as I can estimate, the number of these smaller concerns is near 500.

There are about 300 electrotypers, using 350 dynamos of 200 amperes each, equalling 70,000 amperes, but it would be hard to say how many men are employed.

CONTEMPORARY ELECTRICAL SCIENCE.

IT is not often that we can record the discovery of a simple law, and when it does happen it appears surprising that it was not discovered before. Such a law is enunciated in a paper by Robert Lang in *Wiedemann's Annalen*, No. 11, on the dielectric constants of gases and their chemical properties. The specific inductive capacity K of a gas is determined by its valency. If s is the sum of the valencies of the atoms composing the gaseous molecule or the molecular group, then $(K-1)/s$ = a constant $= 123 \times 10^{-6}$ for all gases at normal temperature and pressure. $K-1$ may be called the electrification number, since it represents that portion of the electrostatic strain which is due to the presence of matter. CO_2, N_2O, and CH_4, having the same valencies, have the same values for K. For CO it is smaller, and C_2H_4 greater, in the proportions of 3 : 4 and 3 : 2 respectively. Hydrogen, being far removed from its critical temperature, occupies a slightly anomalous position. Herr Lang gives a very interesting and suggestive theoretical explanation of the new law.——F. Linde discusses the validity of the Clausius-Mossotti formula for specific inductive capacities in the case of liquefied gases, including CO_2, N_2O, Cl, and of vaseline oil, benzol, and toluol. Plotting the calculated and observed values in curves, the latter are all found to curve the wrong way. ——The influence of electric waves upon electric conductivity has been investigated by H. Haga. Tinfoil gratings mounted in ebonite frames had their resistance altered as much as 40 per cent. by electric waves proceeding from an induction coil 50 cm. off. But the strips had to be very close together (about 0.1 mm.), and they must not be stuck on. The original resistance could be very nearly re-established by concussion.——The circular magnetization of iron wires traversed by electric currents gives rise to strong "extra currents," from which the magnetic susceptibility may be calculated. This was done by I. Klemencic. He found that in soft iron the circular is smaller than the axial susceptibility. On hardening the wire by drawing, the axial susceptibility decreases more quickly than the other. In Bessemer steel the circular considerably exceeds the axial susceptibility.—*London Electrician.*

PAST EXPERIENCE WITH STORAGE BATTERIES.[1]

BY FREDERICK RECKENZAUN, E. E.

A DISCUSSION of the storage battery question by this Institute is so appropriate that I sincerely regret that notice thereof reached me only a few hours before the opening of the meeting, due to my absence in Europe whence I have just returned. Being thus able to make only a very brief contribution, couched in general terms, I wish first of all to heartily endorse Mr. Child's communication. While it contains much that has often been pointed out, advocated and demonstrated in the past, the arguments brought out in favor of the storage battery will bear repetition in view of the fact that the majority of engineers in this country have hitherto persisted in neglecting to fairly entertain them.

On the other hand, it must be conceded that there was cause for this neglect. Storage battery manufacturers in this country concentrated their efforts rather upon the records of their selling departments than upon effecting lasting success for their products. The tendency was rather to show highest capacity and smallest weight and bulk, or at least to make claims for these features, regardless of the conditions to be met; and the selection of type, design of auxiliary devices, manner of installation and methods of operation were treated as if of secondary importance. Engineers and customers in general considered the price of storage batteries high, the manufacturers seemed to agree in that feeling and endeavored to economize in all that pertains to the outfit, to an extent which, as we know, proved detrimental all round. Through years of hard experience gathered by that policy, and contrary to the valuable suggestions offered by the work and success of our European colleagues, this state of affairs predominated until at last it is beginning to be recognized that no less skill, care, scrutiny and liberality is essential to success with the storage battery than with the construction, installation and operation of the plants it is to form an auxiliary of. The storage battery demands as much consideration as steam boilers, engines or the dynamos of an electric plant. It resents the assumption that it may be treated on a par with the coal bin as a storage arrangement.

European electrical engineers, who have long ago settled down to the placing of the storage battery in rank with other principal parts of an electric plant, and who are looking upon this country as being foremost in the quantitative application of electricity, wonder why we stayed so far behind them with the storage battery when all we needed to do was to copy from them and multiply. They have various types in successful use, and a number of manufacturing establishments are doing a substantial and prosperous business.

It may fairly be assumed, and the views which I gathered on the subject tend to bear out the assumption, that to the advantages offered by the storage battery, is to no small extent due the fact that direct current central stations continue to largely predominate over alternating current stations in Europe.

Mr. Childs very appropriately referred to the fallacy of taking the loss involved in the storage battery as the basis for the efficiency for the entire plant, where it only yields a portion of its output to the latter.

Such erroneous assumptions as this have helped to retard the progress of the storage battery here, but chief of all drawbacks unquestionably was the lack of durability, which, having now reached a much more satisfactory measure, should at last bring the success which we were so long looking for.

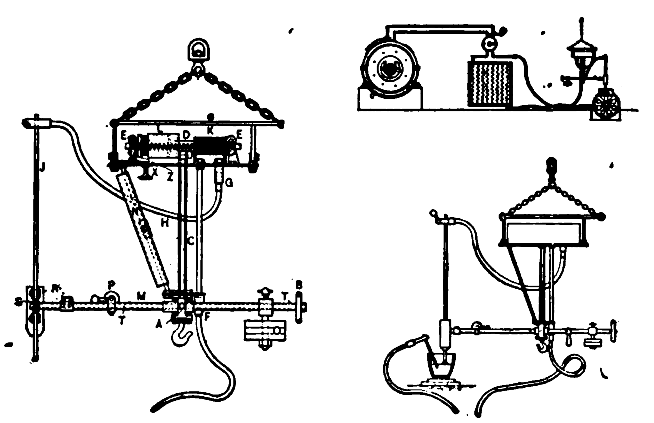
MR. T. A. EDISON in case of a war proposes as our new weapon of offense a stream of water charged with an electric current of 5000 volts, with which to play upon an approaching army. He also suggests aerial torpedoes.

1. A communication presented at the meeting of the American Institute of Electrical Engineers, Nov. 20, 1895.

THE SLAVIANOFF ELECTRIC METAL CASTING SYSTEM.

THE electric casting process devised by Nicolai Slavianoff, a Russian mining engineer, is described at considerable length by A. Lohmann in the *Elektrotechnische Zeitschrift*. The method embodies the principles of both electric casting and welding, and consists mainly in the infusion of metal melted by the electric current upon the surface of a metallic object, whereby the particular parts intimately combine with each other. The fundamental idea comprises the employment of two electrodes, one of which is the material to be cast, while the other may be of a varied nature. The electrode serving as the casting material takes the form of a bar, and is of the same metal which it is proposed to weld. The bar electrode, under the heat of the electric arc, rapidly melts and fills the casting mold underneath. The use of two electrodes, one being the casting metal, is, however, only practicable when the arc is automatically regulated, as will be readily understood. Thus the bar has to be approached in the same proportion as the metal melts and falls down. This operation cannot, however, be performed by hand for any length of time, as a test at once shows. Mr. Slavianoff has, however, devised a method of automatically regulating the arc according as the bar melts away, and which is illustrated in the engraving Fig. 1.

The engraving, Fig. 1, shows the automatic appliance, which is supported in a frame by means of chains and a hook. The lever C carries at its upper end a roller D, arranged between the coils K and L, forming a solenoid. The iron core U is movable horizontally and is carried in the rollers E. Connected at A to the lever C is a hollow shaft, M, carrying the driving bar T, which can be rotated by the hand wheel B. The driving bar T carries at one end a steel toothed wheel, S, against which the metal bar J to be



FIGS. 1, 2 AND 3.—SLAVIANOFF ELECTRIC METAL CASTING SYSTEM.

melted is pressed by means of the roller R, this operation being effected from P. If now, the driving bar T is turned, the toothed wheel S exercises an upward or downward movement upon the casting bar J, corresponding to the direction of rotation of the hand wheel. Arranged on each side of the coils K and L is a spiral spring which, by means of the screw X acting upon the lever Z, can be expanded or compressed. The spiral spring opposes the sucking-in action of the solenoid K and diminishes the sensitiveness of the apparatus. The latter is, to a certain extent, necessary, in consequence of the rapidly varying current strength due to the constant dropping of the melted metal. A similar breaking effect is provided by the movable weight O, connected to the hollow shaft M. The frame N is fitted with colored glass disks so as to protect the eyes of the workmen from the intensity of the arc. The whole of the regulating mechanism is contained in a protective box. The dimensions of the apparatus are: Length from hand wheel to bar electrode, 3 feet; height, 2 feet, and weight, 68 pounds. As will be observed from Fig. 1, the apparatus is constructed as a differential regulator, but the shunt coil is for practical purposes usually cut out. There are, however, cases where two appliance are required for use, and in order to connect the two in series the differential method has been provided.

As already mentioned, the high temperature of the arc rapidly fuses the bar and the liquid metal enters the casting mold. In the same proportion as the bar becomes shorter, the attendant has to bring about the forward travel of the bar. With a little practice this operation becomes easy, as the regulator at once compensates for errors made by the hand. In the main circuit, as indicated in Fig. 2, are also inserted a voltmeter, a resistance, and a pole changer, which play a prominent part in the system. As is known, more heat is developed at the positive than at the negative pole, the ratio being about 2 to 1. This fact causes one to so arrange the direction of the current that the greatest heat shall be produced at the pole chosen as the positive terminal. Experience shows that for melting cast iron, the bar must be connected to the positive pole and the casting mold to the negative. If the direction of the current is reversed, a cast iron is obtained which is white and hard and has little carbon. The resistance, shown in Fig. 2, allows of the spirals being connected in series, in parallel or in groups, and serves to regulate the current strength according to the diameter of the bars operated upon. The current required per square millimeter of cross sectional area of bar to be melted is from 7.5 to 8 amperes, and the pressure from 50 to 70 volts or a mean of 60 volts.

A point of considerable importance in connection with this process in contradistinction to the various electric welding systems is the source of current, as in the former the automatic regulation of the arc allows of the current being taken direct from the dynamo without the use of accumulators. The only condition to be fulfilled is that the dynamo must not have a too sensitive armature, and must be able to deal with sudden changes of load up to 600 amperes. The firm of Julius Pintsch of Berlin, who are licensees both of the Slavianoff electric casting process and the Benardos electric welding system, have used the former method for some time past in their branch establishment in Fürstenwald, on the Spree. The generator in this case is of the Fritsche direct current type, giving, at a speed of 120 revolutions, a maximum of 600 amperes at 70 volts, and a considerable amount of different kinds of work has been carried out.

Among the many applications of the Slavianoff process may be mentioned that of casting small articles without the necessity of melting large masses of metal. This particular sphere of operation is illustrated in Fig. 3, where the bar to be melted is shown arranged in and above a graphite crucible. Other applications of the system include the production of alloys by the use of bars of different metals, the repair of cracks, flaws, holes and worn surfaces; the welding together of different metals, as cast iron on steel, copper and bronze on cast iron, and copper and bronze on steel and iron; repairs of broken parts, locomotive steam cylinders, ship shafts, fly wheels, the conversion of hard white cast iron into soft gray iron, &c. In one instance a large break in the casing of a Westinghouse engine was remedied, and in another a large fly wheel was similarly repaired.

The requisite form for the metal to be cast on to the broken part is obtained first by surrounding the damaged part by a casting mold, the material for which depends more upon the kind of metal to be dealt with. Thus in the case of cast iron the mold is usually made of retort carbon used in the shape of pressed plates 10 mm. in thickness. The material used in the production of iron castings is ordinary commercial bars from 1 to 1½ mm. long. The bits too short for further use in the apparatus are cut into smaller pieces and thrown into the liquid bath.

SOME OF THE OBJECTS AND METHODS OF PHYSICAL SCIENCE.[1]

BY PROF. ALBERT A. MICHELSON, of the University of Chicago.

WE are met to-day to celebrate one of the most important additions to the working facilities of the University of Kansas—the Physics and Electrical Engineering Building.

The association of these two intimately connected and interdependent sciences needs no apology or explanation. It is to-day universally admitted that such an association of pure and applied science is of the greatest mutual benefit. Countless illustrations of the great importance of such close relationships might be given, the mere enumeration of which would take up more than all the time at our disposal. I trust, therefore, that the burden of this brief address will not be misunderstood as implying a bias toward the development of the pure science to the exclusion of its application.

The objects and advantages of the latter are, however, so much more manifest to most of us than the former, that it may not be deemed altogether inappropriate to confine our attention for the present to a few illustrations of the objects which it is the ambition of the student of physical science to attain, and to give a few samples—necessarily very general and brief—of the methods of attacking some of the problems involved.

It is hoped that by this means we may be enabled to form a better conception of the magnificent opportunities which are now placed within our reach by this most wise and generous action of your broad and liberal-minded legislature.

I trust I will be pardoned in using for this purpose illustrations drawn from a single branch of physical science—the one in which the larger part of my own work has been done—and which I confess is to my mind decidedly the most elegant and fascinating of all—from the aesthetic as well as from the scientific standpoint.

The development of the human race is typified by the growth of the child; and as a first evidence of the child's intelligence is exhibited in its first feeble and futile efforts to interpret the sensations which pour in upon its limited understanding, so for ages, in the past history of the race, man has endeavored to observe, to investigate, to classify, to explain, all of the more striking, beauti-

1. An address delivered at the dedication of the Physics and Electrical Engineering Laboratory of the University of Kansas.

ful, grand or wonderful of Nature's works. The immense majority of our impressions are obtained through our sense of sight, and naturally our first efforts were directed to the observation and consideration of things we see. The sky, the earth, the ocean; the sun, the moon, the stars; the gorgeous colors of the sunset; the rainbow, the lightning—what are they? Whence come they? What order is to be found in the maze of their bewildering complexity?

These and like questions have been asked from the time when reason's first feeble efforts began the attempt to solve the problem of existence.

Most of these must remain to our limited intelligence unanswered—perhaps forever unanswerable—save, possibly, the last. To inquire into the *facts* of Nature, to investigate their *relations*, one with another, to ascertain the general *laws* which they obey, to explain their actions and reactions (that is, to *classify* new or hitherto unobserved phenomena among those with which long experience has made us familiar)—these are legitimate and worthy objects of the profound study of the greatest minds.

The physical universe consists of various aggregations of matter concentrated in systems of nebulæ, stars, planets, and satellites, which are separated by immense distances which are almost if not quite void of matter in the sense in which that term is usually understood—as capable of affecting the senses.

The stars affect our sense of sight, and we infer that they are material bodies—and indeed we may even go farther, and say that we know them to be made of the *same kinds* of matter as those with which we are familiar.

Till the most recent times there was no good reason for supposing that the interstellar spaces were not empty voids. But it now seems very probable that these spaces are filled by a very remarkable medium called the ether, the vibrations of which communicate to us, in the form of light and heat, the energy given out by the heavenly bodies. This medium constitutes the one solitary bridge which spans the abyss by which our speck of earth is separated from the rest of the universe.

The probability is very strong that this medium is also a form of matter—possessing, it is true, the properties ordinarily associated with matter in a highly exaggerated form—but differing from it in degree only—not in kind. An extremely ingenious and remarkable theory due to Sir William Thomson, Lord Kelvin, and called "The Vortex Theory," supposes that ordidary matter consists simply of portions of a universal ether differentiated from the rest by their motions.

One step further would lead to one of the grandest generalizations conceivable with regard to the constitution of the physical universe:

There is but one substance—the ether; and the endless variety of phenomena which constitute the physical universe are different modes of motion of its parts.

Of these modes of motion there is one with which we are to a certain extent familiar, from its analogies to the vibrations which produce sound, but which in some respects may better be likened to the motion of water-waves. Of these last, the most familiar example is that of the unruly heavings and tossings of the ocean; but the associations connected with the close contemplation of such motions are not frequently conducive to a state of mind tending toward an appreciation either of its aesthetic features or its use as a scientific illustration. Let us therefore rather retire to a still, smooth sheet of water, and observe the effect of dropping a stone upon its surface. No doubt all of us have at some time watched with interest the ever widening circles of waves, lessening in height as they expand till they are too slight to be visible, or until they are reflected from the shore. The evanescent character of such a wave motion is a necessary consequence of the abrupt character of the cause of the disturbance, and our illustration will be considerably improved if we substitute for the falling stone a motion which is itself regular and continuous, such as that of a pendulum or a balance wheel (*whose regularity* is the basis of their application in clocks and watches). Suppose then a heavy pendulum set swinging in the water; the system of waves to which its motion would give rise would be regular equidistant circles, spreading outward with uniform speed in all directions from the centre of disturbance. If, in the place of the pendulum, a vibrating bell or a tuning fork be substituted, the result will be the same except that since now the recurrence of the impulses is several hundred times as rapid, the waves are very much closer together—the *wave-length* is proportionally less. We naturally associate the term *wave*, with the motions of a water surface; but the signification of the word may be extended to cover any kind of a change which is propagated in any kind of medium. Thus in the case of a sound wave, the medium is usually the air, and the change which is propagated is compression or rarefaction. If the disturbance is irregular, as in the case of a sharp shock or the fall of a load of coal, the resultant sound is a noise. If the cause be regular the result is called a pure musical tone; but if the purity of the tone be carried to the extreme, the effect would be that which I may expect by giving in this discourse too uniform a diet of fact with too sparing a sprinkling of fancy—it will be voted *monotonous*.

In the illustrations given, the condition which is propagated in the form of a wave-motion is something material—palpable; and all the intricate consequences which flow from the simple *mechanical* assumptions may be rigorously calculated by the ordinary processes of analytical mechanics. A striking illustration of the beneficial reactions of practical applications of science is furnished by the advances in dynamo-electric machinery. The vast and continually increasing development of this branch of industry has compelled both scientific men and men of business to familiarize themselves with ideas which but a few years ago had not even a name.

One of the most interesting and promising of these developments is the application of an alternating current of electricity as a source of power.

Upon the practical details of this wonderfully fertile field of electricity—which may almost be considered a science in itself—I do not intend to dwell, but wish merely to utilize the idea of an alternating current as an illustration of the propagation of a wave-motion. The alternating electrical condition which travels along a wire is a true wave.

The fact that ordinarily the length of the waves is enormous—thousands of miles—does not in the least bar it from this classification. The wave-length may readily be found from the known speed with which it travels. This is about two hundred thousand miles per second. Accordingly, if the alternations at the dynamo succeed each other as fast as two hundred per second, the waves will be a thousand miles long; a corresponding sound wave of the same frequency would be only five feet.

Now, if it be desired to produce a more rapid vibration than is obtainable by a tuning-fork, we may use a short, thick, cylindrical steel rod, which when struck laterally gives out a very high tone. If struck lengthwise the tone is so high that it cannot be heard at all. But we may nevertheless calculate its rate, and find that for a rod an inch long this would be a hundred thousand per second. If it were possible to set a rod one thousandth of an inch long in vibration, the rate would be a hundred millions, and then the length of the corresponding electrical waves (supposing that such vibrations could produce them) would be only ten feet. The beautiful experiments executed by the late Dr. Hertz (whose untimely loss is deplored by the whole scientific world) have made it possible to produce and to measure electrical waves still shorter than these and this too without any conducting wire. Imagine now the vibrating rod or its equivalent to be made ten million times smaller; it would then give out electrical waves only $\frac{1}{50000}$ of an inch long. But the vibrating body is now of the same order of magnitude as an *atom of matter* and the length of the resulting electrical wave is the same as that of a *light-wave*. It is thus clear that if a vibrating atom can produce vibrations in the same medium which transmits electrical waves, that these waves would be of the same order of magnitude as a light-wave. But it is proved that both electrical waves and light waves are forms of energy, that both are reflected, refracted, absorbed, and polarized according to the same laws, and that both travel with the same speed. It is impossible to resist the conclusion that they are one and the same thing. If, by any means, it becomes physically possible to replace the minute vibrator by a mechanical device, which will produce the same number of electrical alternations, it may be confidently predicted that the problem of the direct production of light by mechanical power will be solved.

The investigation of hypotheses concerning the constitution of matter, and of the ether, and the true mechanism of light, are among the most important problems in science; and it may be confidently predicted that the time is near at hand when these hypotheses will crystallize from their "mother liquor" of vague speculation into definite and complete working theories. Until this time is reached, however, we cannot hope for any very accurate notion of what light and light waves really are: but we may nevertheless content ourselves with a remarkably exact knowledge of their wonderful properties; and in the meantime make the most of our opportunities in utilizing this marvellously delicate instrument of investigation.

Most of us have at some time looked through the glass pendant of an old-fashioned chandelier and no doubt have noticed the curious "down hill" effect, as well as the brilliant coloring which appears to surround the borders of objects viewed through such a prism. But not even the genius of a Newton could have guessed that a similar experiment *made under appropriate conditions* leads to one of the most wonderful discoveries in modern science. There is an impression among practical people (which however is happily on the decrease) that there is something unreal, unsubstantial—they would express their skepticism by saying "theoretical"—in the conclusions of science; and not infrequently oppose scientific conclusions to those of "common sense"; forgetting that science *is* common sense, refined by subjection to a most rigorous scrutinizing criticism. In the instance just given, crude common sense would be content with the observation that a prism appears to displace the objects viewed and confuses and colors their outline. A scientific man would be content not merely with carefully noting all the phenomena thus casually presented, but would devise ways and means of varying in every possible way all the conditions which he can control in order to eliminate all

unnecessary attendant circumstances, and of bringing into prominent relief the special features which he desires to investigate. This is what is meant by *experiment.*

It is to the genius of Newton that we owe the first accurate experiments on the analysis of light into its constituent colors. This fundamental research, supplemented by the labors of Frauenhofer, Kirchhoff and Bunsen, led to the discovery of the dark and bright lines in the prismatic spectrum, which mark the particular kinds of light which characterize the substances which produce them so that they may be recognized in quantities almost infinitesimal and at distances greatly beyond our conception.

So much has already been accomplished in the use of light as an instrument of investigation that we have come to let our familiarity with the marvels accomplished by its aid diminish our wonder at the results.

One hundred years ago it might have been admitted to be within the bounds of possibility to obtain some rough notion of the distance of the sun, and perhaps of the "fixed stars"; or even an approximately correct idea of their motions in space;—but what enthusiast would be so rash as to predict that it might be possible to know the composition and structure of the sun and the constitution of the stars?

Think of it a moment. Light travels one hundred and eighty-six thousand miles between two ticks of the clock; it would reach us from the moon in less than two seconds, and from the sun in eight minutes. Yet so extremely remote are even the nearest of the stars that, even at this inconceivable speed, their light takes four years to reach us; while for the great majority of them the light by which we now see them was dispatched long before we were born!

And notwithstanding these immense intervals and these distances inconceivably great—so faithful a messenger is light, that he has preserved intact the marvellous record of all that has transpired in those remote spheres of fire. Though the messenger has a language which is perfectly competent to deliver his errand, he is not sufficiently modernized to translate it into "United States" for our especial benefit, but insists that if we would know its burden we must humbly learn to decipher his hieroglyphics.

This we have just begun to do. We have almost learned the alphabet; we have actually succeeded in putting together a few words; and have even caught a glimmering of meaning in a few whole sentences—sentences of momentous import, telling of cyclones of fire, tornadoes of boiling metal, conflagrations vastly greater than the whole world! Such are the mighty truths revealed in reward for the labors of the patient investigator. Such are the incentives to further labor in the hope of new and perhaps even more wonderful results.

From suns and stars to molecules and atoms seems perhaps a long and sudden jump—but our Ariel makes but little distinction in dealing with these magnitudes, be they great or small. The telescope has furnished us with most of our knowledge of the structure of the stellar universe. The spectroscope—when we learn to interpret its indication—will give us an insight into the structure of the molecule. A body or a system of bodies has more than one mode of vibrating—theoretically an infinite variety of ways; but these various kinds of vibrations stand in fixed relations to one another, depending on the shape and structure of the bodies and the forces which hold the parts in place. In the simple case of a cylindrical rod, we may have four such infinite series; and it would be possible—knowing, from the sounds thus produced, the periods of those different modes of vibrations—to deduce from them the *form of the vibrating body* and the motions of its parts. Now we have a number of striking evidences of regularity and of remarkable numerical relations between the vibrations of the light emitted by certain substances, as evidenced by the bright lines which they show when examined by the spectroscope. Does it seem visionary to trust that the accumulation of such evidence is an important step in the desired direction?

It is never safe to affirm that the future of physical science has no marvels in store which may be even more astonishing than those of the past; but it seems probable that most of the grand underlying principles have now been firmly established and that further advances are to be sought chiefly in the rigorous application of these principles to all the phenomena which come under our notice. It is here that the science of measurement shows its importance—where quantitative work is more to be desired than merely qualitative results. It is an almost daily task of the scientific student and investigator to reply to queries concerning the practical use of such an extraordinary degree of refinement as is shown in almost every modern scientifically conducted experiment. It is frequently admitted that these uses are not practical—but I would not concede even this much. Two thousand years ago there was no occasion for divisions smaller than an inch. Two hundred years ago measurements smaller than one-sixteenth of an inch were required of only the most careful workmen. Twenty years ago—outside of scientific measurements—a thousandth of an inch was nil. To-day an error of this magnitude in one of our modern engines would mean all the difference between success and failure. If now it be granted that for *scientific* work, upon which every practical advance depends, the order of accuracy is from ten to one hundred times as great as this, who can say what will be required two hundred years—nay, twenty years hence? These are undoubtedly sufficiently weighty reasons for the time and care which are indispensable in properly conducted scientific work—but unquestionably, the most important reason of all is, that by such work, and by such work alone, must we look for the steady onward march of science, by which alone truth is to be dug from its well and placed upon a foundation more solid and enduring than the pyramids.

An eminent physicist has remarked that the future truths of physical science are to be looked for in the sixth place of decimals. In order to make such results possible the student and investigator must have at his disposal the methods and results of his predecessors, must know how to gauge their value, and to apply them to his own work; and especially must he have at his command all the modern appliances and instruments of precision which constitute a well-equipped physical laboratory—without which results of real value *can* be obtained, but only at immense sacrifice of time and labor.

The science of Astronomy appeals far more powerfully to most minds than does physical science; which indeed to many is scarcely known even by name. The former is as old as history. Its wonders have compelled the attention of mankind from the earliest ages, and it is but a natural consequence, that at the present day no important city in the civilized world is without its richly endowed observatory where its trained corps of astronomers is able to study the phenomena of the life of suns and worlds and their distribution in space and time. It is only in very recent times that it has begun to dawn upon the mind of man that there is another world only one degree less complex and wonderful than the stellar universe—the world of molecules and atoms.

For the study of these infinitesimal systems of pigmy stars we have, it is true, no telescope, or even microscope to help us; but little by little we are constructing a powerful logical engine which is destined at no very distant day to bring the revolutions, rotations, and oscillations of these minute orbs as clearly to the mind's eye as are now the motions of the world and suns of the greater physical universe.

When will the Kepler come to marshal the present ever-increasing array of facts and queries into one great and consistent whole? When will a second Newton appear to solve the riddle of that complex microcosm we call a molecule? This, their problem; to penetrate, as far as it is permitted to human reason, that wonderful mysterious whole we call matter, whose solar systems are molecules, whose worlds are atoms.

LITERATURE.

The Wonders of Modern Mechanism. By Charles Henry Cochrane. Philadelphia, J. B. Lippincott Co. 1896. Cloth. 8vo. Illus. pp. 402. Price, $2.

This book sums up in a popular way, yet with clearness and accuracy, the recent advances of industry and invention. The object is to exemplify what has been done within the last year or two in various branches of engineering, and to indicate the directions in which the foremost inventors of the age are working. Electricity is liberally included and little of importance has been overlooked. It is natural that some parts of the book should incline to the nature of "glittering generalities," but Mr. Cochrane has a practical mind and has pinned the facts down whenever he could catch them. A review of this sort from year to year would be very useful. The illustrations, like the text, are clear and instructive.

LETTERS TO THE EDITOR.

THE WORTH OF THE ELECTRICAL ENGINEER.

I have read with great interest your excellent circular on "The Selection of an Electrical Paper for 1896." Your logic is irresistible. I hardly appreciated all the good things the ENGINEER brought to my table, until I read in condensed form the *résumé* of the menus you served in 1895! Truly you gave us palatable dishes, and the finishing touch was the advent of your Data Sheets.

I congratulate you upon the far-sightedness which led you to give these sheets to a hungry public almost "without money and without price."

I believe in THE ELECTRICAL ENGINEER, for I've tested its worth. To my mind, not the least of its advantages, is the fact that it stands as an apostle of high-toned journalism and does not traduce or malign competitors. It's clean and worthy of imitation.

You are at liberty to publish this if you see fit. Please renew my subscription and that of the Standard Air-Brake Company and the Moore Electrical Company for 1896.

E. J. WESSELS,
General Manager, Standard Air-Brake Co.

NEW YORK CITY.

THE

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CONTENTS.

1895.

THE past year has been one in which electrical development was noteworthy chiefly in the field of power transmission. It saw the starting of the plant at Niagara Falls, an event of vast importance, and the work at Folsom and other places. Besides this, a large number of factories, iron works, docks, etc., have been equipped with individual power plants, and central stations have more than ever devoted their energies to building up a motor patronage.

The electric railway field has seen three striking advances in the equipment of the Nantasket Beach steam branch of the Consolidated Road; the Mt. Holly steam branch of the Pennsylvania Railroad and the Baltimore tunnel of the B. & O. In each instance, electricity has proved an emphatic success. During the year also, conduit street railways have come rapidly forward as mechanically and electrically operative; and even the storage battery has again been put forward as the best method of all. The Chicago Metropolitan Elevated also went into successful operation.

In lighting there has been little that is really new, but hope is hovering eagerly on the edge of the future when we are to have a light that is cold and lamps that never burn out. The growth of arc lighting has not been conspicuously large, but the dynamos are bigger than ever. Alternating arcs and constant potential arcs have been greatly improved, and some new constant current arcs of merit have made their way into the market. A bad feature has been the low price of incandescent lamps. Good lamps cannot be made and sold at the average quotations, and the customer will only get the poorer quality he is paying for. Another feature which has attached attention during the year is the advent of electrically produced acetylene, as a proposed competitor to the incandescent lamp. Nothing has been done towards its practical distribution thus far, though many appear anxious as to its possible influence on the industry.

The "boom" expected in telephony as a result of the disappearance of patent restraints has not been seen or felt. There has been a brisk outburst of competition and many places heretofore without exchange service now enjoy it; while private telephone lines have multiplied apace. But in many of the larger cities, the attempt at competition has brought rates to a level which will not support life in any system; while elsewhere the existing exchanges have done marvels in the way of bettering their service. New York City strikes us as an example of intelligent and progressive management, and the rates and inducements offered by the Metropolitan Co. are such that rivalry is rendered well-nigh impossible. Competing exchanges in any city have always appeared to us an example of two bodies occupying the same space; and it is certain that the public will reward with its exclusive patronage the service that is steadily the best.

Telegraphy during 1895 has been notable chiefly for the extension of the Postal Company's lines and the opening by it of several fine new offices with the latest modern equipment. The Western Union's business meantime has not shown any revival, although the introduction of copper circuits has gone on. This present year sees the expiration of the old Western Union-American Bell contract in November, and curiosity is aroused as to what may happen, for the experience of 1895 has shown that many things are possible.

OPERATION OF THE PENNSYLVANIA BURLINGTON BRANCH ELECTRICALLY.

THE Mt. Holly-Burlington branch of the Pennsylvania road, equipped with Westinghouse apparatus, appears to be yielding excellent results. With even the temporary apparatus, the railroad people have had a number of surprises, such as stopping with air brakes when going down a 2 per cent. grade on a rainy day at 48 miles an hour, in 300 ft. The train on that occasion consisted of one motor car and two trail cars, one of the latter being a regular P. R. R. passenger coach and the other a P. R. R. standard baggage car, altogether a train weighing 65 tons. The same train was started on a 2 per cent. grade (up grade) and acquired a speed of 45 miles an hour in a run of about one mile. These figures and data, as well as more of similar nature, would seem to indicate the entire practicability of supplanting steam by electricity on long as well as short hauls on steam roads, and the ease with which electricity could handle even the largest trains.

ARTIFICIAL LIGHT PROBLEMS.

ONE of the great problems of the age held up to courageous and farsighted inventors is the production of light without heat; and the light of the glow worm has become the standard of reference, as it were, by which the new light is to be judged. But it seems that this is wrong and that the public is destined to a rude awakening. We are now told that, after all, the glow worm light is not the one to be sought after, and indeed is not nearly as good as can be attained from the present type of incandescent lamp. This, of course, does not refer to the efficiency of the lamp, but to the character of the light from the purely physiological standpoint. It has long been known that the candle power of a source of light as measured in the photometer is no true index of its illuminating effect on surrounding objects of various colors. All reds and browns, for example, absorb the larger part, in fact nearly the whole of the blue, green and violet light which falls on them; consequently in a room finished in warm tones the wall absorbs a disproportionate amount of the light from the incandescent lamp and reflects only 15 per cent. of the light which falls on it, making the room look gray and gloomy. A scarlet is reduced to a crimson, and a mixed red to gray by the blue of the electrically heated carbon when the light falls directly on it.

Now, by studying the reflection spectrum of a colored room by daylight and determining its absorption area, and then obtaining the same area by tinting the glass of the globes, we may obtain an artificial light of ortho-chromatic scale. At the same time we bring down the over-reflection of violet from the whites, blues and blue-greens and consequently we relieve the eye strain, the pupil expands and more light is admitted

Based on this reasoning Dr. W. H. Birchmore, whose highly interesting contribution is printed elsewhere in this issue, claims that it is possible by means of certain combinations to alter the spectrum of transmission just as Abbe and Zeiss have altered that of refraction—by which they have perfected photograph and microscope objectives—and thus adapt the emitted spectrum to the room. This is not surrounding the filament by a ground-glass or colored bulb or globe making the light monochromatic, but it is equivalent to making an algebraic equation of certain wave lengths.

This can be done without seriously impeaching the candle power as measured by the Bunsen photometer, but on the other hand by increasing the amount of reflected light and relieving the eye strain at the same time, the amount of light entering the eye is vastly increased.

As it stands now, the reflection spectrum value of a 16 C. P. lamp upon reds, and browns, is not quite as much as that of a paraffin test candle, while from violet it is near 50 times. Thus violets are too bright and all bright colors are painful to the eyes, reducing the pupil. Dr. Birchmore has developed a simple method of tinting glass by which he claims that the color scheme of a room by incandescent lamp light can be made the same as by day, every color taking nearly or quite its true value. A room finished in warm tones can be habitable in the evening, and the ghostlike white rooms to which decorators are being driven as a last refuge from the violet light be avoided.

If Dr. Birchmore's principles shall prove to be well founded in fact, and experiments to that end indicate that they are,—the usefulness of the present sources of illumination will be largely increased, the incandescent lamp especially being specially adapted to the proposed method of bulb tinting.

LOWER STREET CAR FARES.

THE introduction of electricity on street railways has done much for the public, and one of the greatest boons has been the longer distances over which it has enabled passengers to travel for the same amount of money—usually the single nickel. At the present time, however, there are evidences of dissatisfaction in many cities, and a widespread agitation is in progress for lower fares. In fact, the reduction has already begun. In Detroit, on the new road, the average cost of a ride approximates to a three cent fare, and Dr Everett now offers a corresponding rate for his projected new system in Cleveland. In Detroit also, on the old Citizens' system, Mr. Tom L. Johnson is offering four tickets for 15 cents, and in Chicago the General Electric road is selling seven rides for 25 cents. The new Buffalo Traction Co. has just been given a franchise with a four cent fare clause in it, and so it goes all along the line. The signs of the times are unmistakable.

But there remains a good deal to be said on the side of a maintenance of the time-honored 5 cent fare, and not the least of the arguments is found in the necessity that many of the city roads may soon be under to adopt conduit or kindred methods of operation. The change will be costly, and it cannot be carried out unless the companies are able either to do the work out of revenue or can sell new stock. The income from 3 cent fares is inadequate and capital will not be readily elicited in face of diminished returns.

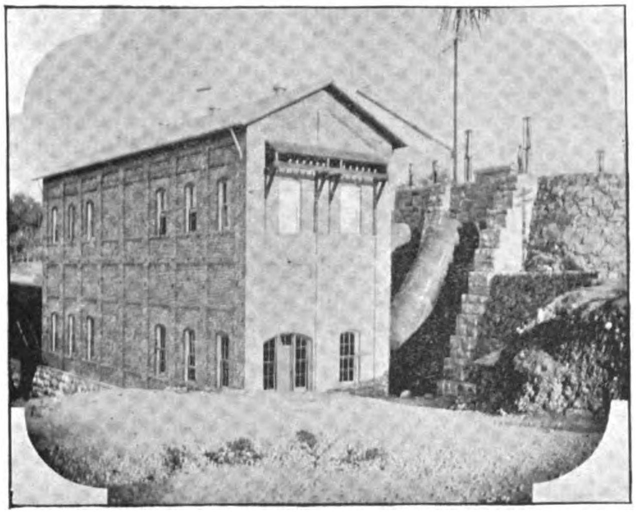
It seems to us that among the rational ways of dealing with the situation is that of making special rates for work people morning and evening; and that another proper and scientific way is to grade the length of travel by the fare. It is to be borne in mind also that a lower rate will not tend to make things more comfortable for passengers. On large lines at busy hours, the cars are already dangerously close, and any increase of travel cannot lessen the headway but must on the contrary intensify the crowding.

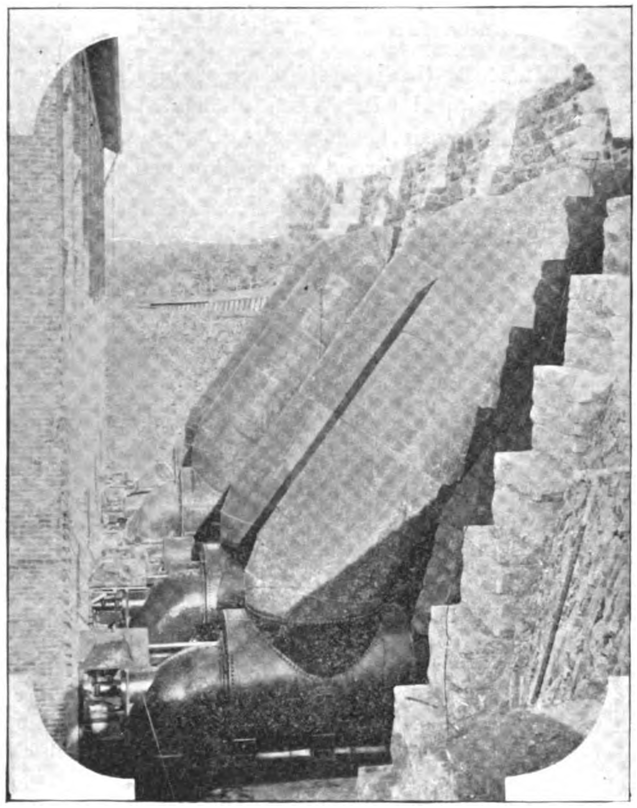
As a matter of fact, the chance of picking up extra nickels, has led the trolley companies frequently to extend their lines unduly, and to put down tracks which cannot earn a revenue. The lower fare will check this expansion to the detriment of modest house owners and will restrict the suburban growth which has been so notable during the last seven or eight years. A 3-cent fare is not much benefit to anybody who has to pay a higher rent or real estate value in consequence of its enforcement. So, too, with regard to general accommodations, it is obvious that so sharp a reduction in income will greatly lessen the ability of a corporation to improve its plant, renew its cars, or go on introducing the many little novelties that have made the trolley so beneficial an influence in city life.

POWER TRANSMISSION.

THE HYDRAULIC PLANT OF THE FOLSOM-SACRAMENTO TRANSMISSION.

One of the most successful long distance 3-phase transmission plants thus far put into operation in the United States is that between Folsom and Sacramento, California. By damming the American River a fall 70 feet has been made available, capable of delivering 10,000 H. P. The distance of transmission from the dam at Folsom to Sacramento is 23 miles and by employing a potential of 10,000 volts, 1,000 H. P. can be transmitted over three wires of No. 1 B. & S. gauge each, four such circuits being employed.





FIGS. 2 AND 3.—POWER HOUSE AND TURBINES, FOLSOM-SACRAMENTO POWER TRANSMISSION PLANT.

Our issues of Feb. 13 and July 31, 1895, gave full details of the electrical equipment of this plant At the latter date but one forebay was completed, but on Oct. 1, the remaining forebay was finished, giving the plant its full operating capacity.

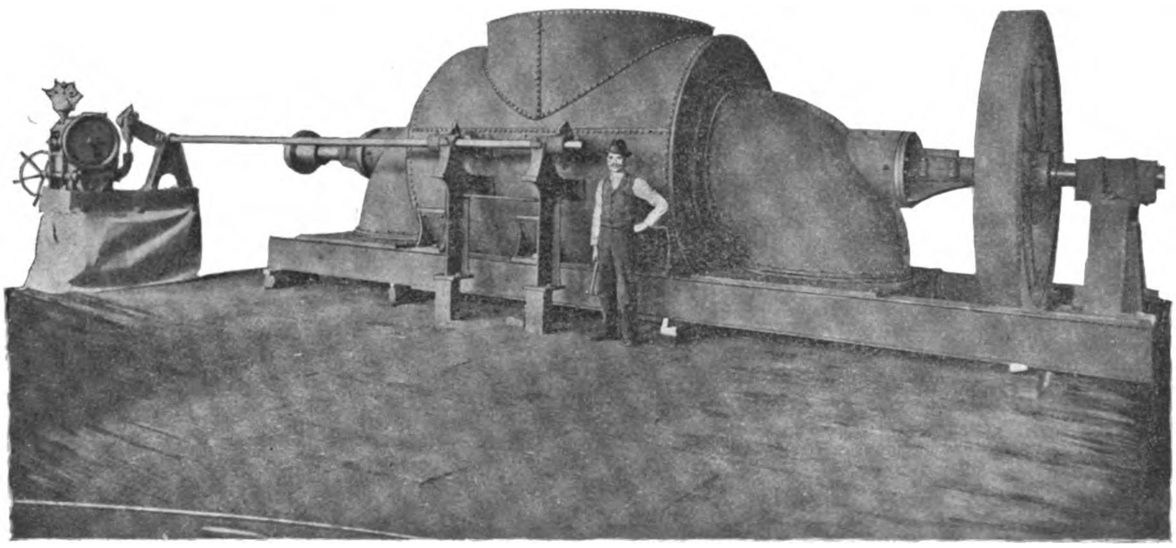


FIG. 1.—MCCORMICK TURBINES USED IN FOLSOM-SACRAMENTO TRANSMISSION PLANT.

The hydraulic plant consists of four pairs of phosphor bronze McCormick turbines, built by the S. Morgan-Smith Iron Works, of York, Pa., under contract with the Pelton Water Wheel Co. Each of these pairs, illustrated in the accompanying engraving, Fig. 1, has a capacity of 1260 H. P.

With an available head of 55 feet, the wheels make 300 revolutions per minute, the water being led to the turbines by 8 ft. inlet pipes made of $\frac{5}{8}$ inch steel.

An interesting feature in connection with these wheels is the addition of fly-wheels to assist in the governing. For this purpose each pair of wheels is provided with a 10-foot steel fly-wheel weighing 10,000 pounds and giving a peripheral speed of 9,425 feet per minute. Heavy steel tires shrunk on the rims provide for the centrifugal strain.

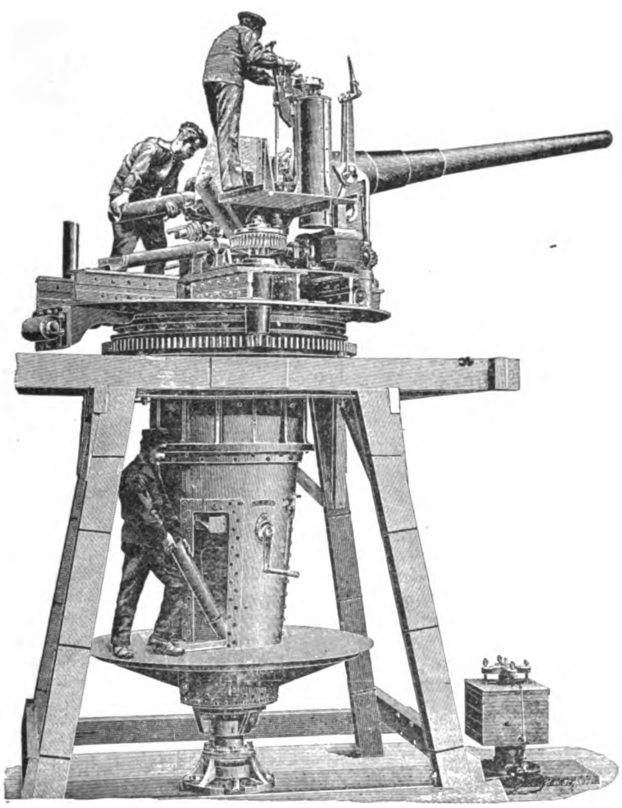
The exciting dynamos are run by two small special wheels. The Faesch-Picard governor, similar to that employed in connection with the Niagara 5,000 H. P. dynamos is here used.

Each of these turbines is coupled direct to a 750 K. W. General Electric 3-phase generator. These machines have 24 poles and at 60 cycles deliver current at 800 volts to the step-up transformers which transform it to 10,000 volts used on the line.

Our engraving Fig. 2, gives a view of the power house, showing the inlet tubes and cross-arm which carries the insulators for the main line wires.

CANET ELECTRICALLY WORKED TURRET.

SINCE less than a year ago, says *Engineering*, the progress made by Mr. Canet in the introduction of his system has been more rapid than might have been expected, not only with the French marine, but with foreign governments, and at the present time the Société des Forges et Chantiers de la Mediterranée has completed, or is completing, no less than 40 turrets of various sizes for different vessels; among these the most important are the Latouche-Tréville, the Jaureguiberry, the D'Entrecasteux, the Pothuan, the St. Louis, the Capitan Prat, the Skjold, and the Carlos V. The turrets most recently completed are intended for the armament of the coastguard ship Skjold, belonging to the Danish fleet. The installation consists of three turrets and the associated machinery; one of these is for carrying a 24-centimetre (9.45 in.) gun, and two turrets for guns of 12 centimetres (4. 72 in.). All of these are closed turrets, and as in other installations on the Canet system of the same class, they are provided with hand, as well as with electrical gear, so arranged that either can be employed by shifting a transmission clutch, so that it is possible to pass from one to the other method of driving, without any appreciable delay. Electrically worked gear has been applied, in the case of the larger turret, to the mechanism for training the 24-centimetre gun, as well as to the ammunition hoists; in the smaller turrets it is only used for training the 12 centimetre guns horizontally. Ammunition is raised to the gun platform by means of an endless chain and carriers worked by hand, a method which assures an ample supply for these lighter calibres. The device employed for the training of the guns is the "electrical cartridge.



CANET ELECTRICALLY WORKED TURRET.

The excellent results obtained on the Latouche-Tréville with this apparatus have been fully confirmed by the recent trials on board the Skjold that were carried out at Havre, in presence of the Danish Commission appointed to examine and receive the vessel. These trials have certainly demonstrated the reliability, under all conditions, of the Canet-Hillairet-Huguet "cartouche electrique." The man in charge of the turret is always enabled to hold it under complete control; not only is he able to arrest the movement of the platform suddenly at any desired moment, no matter what velocity is imparted to the turret, without creating any shock or reaction to the heavy moving mass, but he is able at will to make the fine adjustment in training with great facility and speed through distances less than one-fortieth of a degree. Tests of this class were repeatedly carried out at the trials in the presence of a large number of French and foreign naval officers. By the special arrangements introduced into the Canet turret, and the care with which all the parts making up the system are counterbalanced, the power required to revolve the moving parts is reduced to a minimum. The work of turning the turret of the 24-centimetre gun, with its heavy platform, armored protection, and the gun itself, is performed with a 15 horse-power electric motor, or rather that is the nominal power of the motor provided, but as a matter of fact only about two-thirds of this energy are required. A 8 horse-power electric motor is sufficient for effecting all the operations of training the 12-centimetre guns and their lighter turrets. The ammunition hoist of the 24-centimetre gun is driven by a separate electric motor of 8 horse-power; this motor is controlled by a special type of controller which imparts the intermittent motions required for charging the hoist and raising and delivering the ammunition on the gun platform; the action of the commutator is entirely automatic, and it is provided with a safety device. The illustration that we publish shows the arrangement of the turret, mountings, training gear, and ammunition hoist on board the Skjold; the smaller turrets are similar, with the exceptions already described.

POSSIBILITIES OF POWER DISTRIBUTION IN PITTSBURGH.[1]

A PAPER containing novel ideas was read last evening by L. B. Stillwell at the meeting of the engineers' society in Carnegie Hall, Allegheny. The paper went to prove the possibility of doing away, by the use of electricity, with the smoke and soot that hang like a pall over Pittsburgh. Although the author did not admit the justice of the claim that a good plan, to be adopted, must be more economical than methods already in use, he stood ready to prove that his proposition was actually cheaper. The paper was on the "Possibilities of Electrical Distribution of Power in Pittsburgh." Mr. Stillwell started out with the assumption that these three propositions are not necessary to demonstrate, but are already admitted—that Pittsburg is an exceptionally smoky city; that smoke is largely due to imperfect combustion in boiler fires, and that electricity is an efficient and convenient means of distributing power from a central station.

Imagining a committee of the engineers' society suspended in a balloon over the city, basking in the sunshine, while below lay the city, a spot of soot on the earth's surface; supposing the committee to be possessed of full information regarding the poor average economy in the use of fuel, the loss of coal by breakage and weathering, and the low percentage of power derived from the combustion of coal, and delivered to the steam engine from the boiler, Mr. Stillwell concluded that the committee would decide that no small-power plants producing smoke ought to be tolerated, and that every wheel of industry in Pittsburgh and Allegheny should be turned by energy developed in a central station, where the production of smoke could be absolutely avoided. The committee, he said, would not take the view that this plan ought not to be considered, unless its advocates could demonstrate that it would directly and immediately save money for those using the power, but would be inclined to think that a man does not, necessarily, possess the right to impose smoke and soot upon his neighbors merely because it has been his habit to do so.

From a series of calculations Mr. Stillwell deduced that in the central wards of Pittsburgh and Allegheny a marked saving for the users of power would result, in the case of all but very large steam plants, from the substitution of electric motors supplied with energy from a 20,000 horse-power central station. He suggested two plans, one a central station located 10 miles from the court house and one installed in the city, preferably on the banks of the Monongahela near the coal supply. He considered the second plan the better.

To install a 20,000 horse-power electric plant in the city would cost, Mr. Stillwell estimated, $3,000,000, and the total annual charges, including operating expenses, maintenance, taxes, insurance and interest on investment, would not exceed $600,000. Such a plant would be capable of delivering to the premises of the users of power 17,000 horse-power. Allowing for three per cent. for losses in the transformers and 15 per cent. for average losses in the motors installed by the users of power, the plant could deliver at the shafts of these motors 14,000 horse-power at any given time. As all the customers would not always be using the maximum of power which their motors could develop, it should be possible to supply from such a plant motors aggregating not less than 20,000 horse-power.

Allowing annual dividends of 10 per cent. on the $3,000,000

1. *Pittsburgh Post*, Dec. 20.

investment, to be added to the annual charges, making a total of $900,000 per annum, the cost per horse power, calculating that the plant would supply 20,000 horse-power, would be $45 a year. This figure, Mr. Stillwell said, is considerably under the average cost in Pittsburg, excluding from consideration plants using more than 2,000 horse-power.

THE NEW ELECTRICAL PLANT IN THE U. S. PRINTING OFFICE AT WASHINGTON, D. C.[1]

BY W. H. TAPLEY, CHIEF ELECTRICIAN.

THE plant consists of one 187½ K. W. direct-connected generator and three 80 K. W. belted generators, all of the most improved compound multipolar Westinghouse type. The 187½ K. W. generator is directly connected with a Westinghouse compound condensing engine of 250 horse power. The two machines occupy a floor space of 21 by 7½ feet. The 80 K. W. generators are driven from a line shaft, which is belted to a 250 horse power compound condensing engine of the marine type. Friction clutch pulleys are used for driving these generators, thus giving the greatest flexibility to the plant by allowing the stopping of any one of the three generators while the others are in use. These, independent of the direct-connected generator, are capable of furnishing all the necessary power as well as light needed in the office in case a total breakdown of the direct-connected unit occurs. The total capacity of the four generators is 8,500 50-watt 16-candle power incandescent lamps—more than sufficient for all lighting and power demands.

The peculiarities of the work of the office make necessary a sectional rather than a general system of electric lighting. With this end in view, the wiring has been done entirely on the "crib" system. This affords a uniform distribution of light throughout every division of the office, the rooms farthest away from the generator station being equally as well lighted as those near by. So perfect is this result that nowhere in the building does the variation from the switch board to lamp exceed 2½ volts, nor is the variation in any one room ever more than one-fourth to one-half volt, no matter how many or how few lamps may be burning on the circuit. The capacity of all main trunk lines and feeders is so large that circuit regulators on the switch board are not required.

To make up any loss from generator to lamp, the generators are overcompounded 1½ per cent., and their makers guarantee that no greater loss than 8 per cent. will occur from full to no load. Thus there will be a constant voltage at the lamps, whatever may be the existing conditions, insuring full candle power and the long life of the lamps. We are thus able to get full benefit of the current generated and not have a considerable portion of it consumed in rheostats that the system may be kept in balance.

The crib system has been extended to vertical mains as well, thus allowing the disconnecting of one side of the circuit without interrupting the service throughout that circuit while in use. The crib system of wiring not only increases the flexibility of the plant, but minimizes the possibilities of interruption of work, and also equalizes the distribution of current to the lighting mains.

In carrying out the instructions as to the application of electrical power, the office will use at present seventy Crocker-Wheeler electric motors of one-sixth horse power to 30 horse power, aggregating 225 horse power.

To secure full protection against any possible interruption of work, except through a total failure of steam power by accident, a suitable electrical switch board of special design became necessary. This board is one of the largest and most complete in the country. It presents many peculiar features and fully meets the exactions of the service here, which will not permit interruptions during the sessions of Congress. The switch board is divided into five panels—three for lighting and two for power. It is so constructed that an additional panel may be made without changing any of the connections. There are two sets of bus bars extending the entire length of the board—one for the use of the lighting circuits and the other for power circuits. By the use of a switch the two bus bars can be connected so as to make one continuous bus bar, and power and lighting circuits may be run together and from one generator should occasion therefor occur. Each generator is connected to the switch board by a double pole double-throw switch, thus allowing any generator to be used for power or lighting as occasion may require. Each feeder circuit is also controlled by a double-pole double-throw switch, giving every circuit throughout the building two sources of current and providing for an uninterrupted system either of light or power. Under normal conditions all lights will be run from one set of bus bars and the power circuits from the other, but when both power and lighting load become sufficiently small so that the combined demands of both are not in excess of the power of one 80 K. W. generator, all work will be so divided by the switch board as to make it possible to run everything from one generator. This board allows the changing from one generator to the other without any interruption to the service in the building or the running of the generators in multiple.

Each panel is provided with a standard Weston volt and ammeter. Each power circuit is supplied with a round pattern Weston ammeter. There is also connected to the lighting service a recording voltmeter. For testing insulation of each circuit there is a special reading in ohms marked on one of the voltmeters, thus enabling a daily log to be kept of the condition of each circuit of the plant. The measuring will be done by drop-of-potential method, and not only will each individual circuit be tested, but each leg of each circuit, a suitable switch being provided for the purpose.

More than 20 miles of wire of the best kind was used in the circuits, and during its erection full use was made of every precaution known that would render property and life more safe.

The insulation test of this entire system with all cut-outs in circuit will reach, under ordinary conditions, 8 megohms.

One of the special features of this electrical plant is the transmission of power by electricity. In all cases where it was possible so to do without interrupting work, we have connected motors direct to the machines themselves, doing away entirely with the use of belting and its attendant losses, disadvantages, and dangers. We find that the printing presses and some of the other large machines were never driven to their full capacity by belts, and that since they have been geared direct to the electric motors nearly double the amount of work has been done on some of them.

In gearing motors direct to printing presses we have not only secured the advantage of displacing belting, but enabled the pressman, by the use of a reversing regulator, to have absolute control of his press when making ready, and move the bed plate forward or backward, as desired, and without the help of a laborer. The speed of the press can also be regulated at will.

The two principal advantages of electric motive power over shafts and belts are the reduction of the friction load to a minimum and the independent working of each machine. Under the shaft-and-belt system the breaking of a belt often necessitated the shutting down of all the mechanical divisions.

To each motor is attached an automatic cut-off, so that accidents are not liable to occur through carelessness of employees. A still further safeguard is the automatic circuit breaker, which prevents the overloading of motors.

In the erection of the plant every approved electrical device has been used. The short period during which the new plant has been in operation prevents full statements as to the amount of current and power consumed by each division of the office and the actual amount of power saved, as compared with the old system.

1. Report to T. E. Benedict, Public Printer.

UTILIZING THE WATER POWER OF THE LAKE OF THE WOODS.

Among the water-power enterprises lately developed, one of the most noteworthy in many respects is the work of the Keewatin Power Company at the outlet of the Lake of the Woods, Canada. The company's constructions are of gigantic proportions, and are expected to supply a minimum of 40,000 horse-power in the dryest seasons. The Lake of the Woods covers an area of 3,000 square miles, is fed by the Rainy River and many small streams draining an area of about 30,000 square miles The ambitious design of converting this great lake into a mill pond and its outlet into power flumes by an enormous dam across the Winnipeg River has already been carried to a successful issue. This dam, with its long row of massive granite piers built on the solid rock of the river-bed, is a structure as permanent as the rocky shores of the river. It has been constructed with all the requisites for retaining and regulating the flow of water, and the head maintained for the flumes is about 21 feet. The commercial and industrial possibilities of this 40,000 horse power supplied by nature in a district surrounded by abundant wooded land, and in the excellent farming country between Winnipeg and Lake Superior, can scarcely be overestimated. The many inventions which have multiplied the uses of wood fibre will be advantageously turned to practical use in a district where cheap power and an abundance of the pulp woods are found together. The ever-increasing harvests of the Northwest will also, in the natural course of events call for increasing milling capacity, and cheap power will be a material factor in transferring to the western continent the work of grinding wheat for the European consumers.

ELECTRIC POWER AT JACKSONVILLE, FLA.

THE application of electricity to power purposes in Jacksonville is rapidly extending. During the last week Mr. Johnson Law has installed two Eddy motors, one for Dick Oldham and one for the Hilditch branch laundry on Bay street. The Cleveland Furniture company has also ordered from him a five horse-power Card multipolar slow-speed motor for the new factory in LaVilla.

THE CHICAGO GENERAL RAILWAY CO. has decided to sell seven tickets for 25 cents.

ELECTRIC TRANSPORTATION DEPARTMENT.

MR. YERKES ON MUNICIPAL OWNERSHIP OF STREET CAR SERVICE.[1]

"I DEEM municipal control of street car lines undesirable. It is not for the best interests of the people, and the operation of street car lines by public officials would be impracticable in this country. It is not a matter which admits of discussion. To contend any industry can be operated as well or as economically by public officials as by private corporations is ridiculous. The very fact the officials are continually changing would defeat any such plan. I know of no other business where education is so necessary as in that of street railroads. Few even of those people who have been connected with them for years, are thoroughly conversant with the requirements of their successful mangement. It is a business full of detail from the top to the bottom, and requires a lifetime of study and attention to fully understand. How, then, could it be expected a public official appointed, say, every two years, would be able to direct the operation of a system? It would take him that long to fully comprehend the duties of the employés.

"As for a proper understanding of the necessities, the economies, and the management of the roads, it can only be had by experience and a natural aptitude for the business.

"The great railway systems are successes only because they are intelligently managed. The net earnings divided among the stockholders is but a small portion of the gross receipts, and a little bad management could easily eat up that and more.

"But the City of Chicago manages its own water-works and electric light system," was suggested.

"Yes," said Mr. Yerkes, "and we all know there are no large industries in this city so poorly or extravagantly managed as those under the control of the city government. The cost of supplying the people with water is much greater than it would be if done by a private corporation, and while we have no data in this city with which to compare the work of the Water Department, yet when placed beside the cost to corporations supplying towns with water we see how much more economical the corporation management is. There is no doubt there is enough money wasted to make a good dividend for a private corporation."

"But the electric light system?"

"In our electric light department," Mr. Yerkes grimly replied, "the most absurd condition is shown. This is one place where we can make a comparison between the municipal and private operation of an article used by the public. The plant of the city electrical department cost much more than it could have been built for by private corporations. In fact, the prices paid were most extravagant.

"The operation of the electric plant is to-day a disgrace to this community. There is not another large city in the country, and I doubt if there is one in the world, where it costs so much for public lighting as in Chicago, and I know of no city where the prices are as low as those of our private corporations. Counting the interest on the plant, and the cost of operating the total cost to the city is the stupendous sum of $165 a lamp a year. There is but one thing in excuse of this extravagance, and that is the wires in the heart of the city are underground. But allowing for this, when we compare this cost with the prices charged by private corporations in other cities the result is startling. In St. Louis the city pays the local company $74.75 a lamp a year. In Cincinnati the price is $70, and in Indianapolis $85. I have no doubt the local company in this city would be glad to make a contract to supply our light at a reduction of fully 50 per cent., providing it could make a contract for such a length of time as would warrant it in putting in an underground system in the heart of the city."

Here Mr. Yerkes took up the political aspect of the question and continued: "If it is not economical or practicable to operate these industries by the municipality there can be only one reason why it should be done, and that is to support an army of politicians and their supporters, who, we all know, care little for work and who are of no service to the industry they may pretend to be engaged in. Suppose the street railway systems of Chicago were turned over to the city, who would operate them? Perhaps the Commissioner of Public Works or his Superintendent of Street Railways, a person who must have a political pull to be appointed to the position. He would, in all probability, be a man who knew but little if anything about the business.

"Then who would be his employés? The conductors, gripmen, and motormen would be the people who were valuable in the different wards in times of election. These thousands of conductors, who are really the cashiers for the railways, would be men who owed their position to the head of the department or the Alderman of their ward. The situation, while serious to contemplate, would be laughable.

"Then what a power it would give the political party in control! The North and West Side street car systems, together with the elevated and branch lines, employ 6,000 men. The other lines perhaps 4,000 more, making a total of 10,000 in the city. At election time every man would know a change of administration meant his probable discharge. Then, again, if it were necessary for the administration to have more votes, at least 50 per cent. more people could be placed in positions as extra men, and for other purposes.

"The best object lesson of this sort of thing," continued Mr. Yerkes, "I know of was given in Philadelphia when the municipality purchased and ran the gas works of that city. For twenty-five years the trustees of the city gas works practically ran the city. The law provided the Council should elect the trustees who managed the gas works. But the trustees nominated and elected the Council. It was a difficult matter for any one to be a member of the Council unless he had the approval of the gas trustees.

"In Europe, where there is a monarchical system of government, the plan of municipal control of corporations might succeed. The head of the department would be appointed by the ruler and be held strictly responsible for his acts. The best talent of the kingdom would, in all probability, be employed. In Europe, except in England, most of the railroads, both steam and street, are run under government supervision. But the conditions there and here are radically different. There it is necessary for the government to have constant control of the railroads. Hundreds of thousands of troops are constantly under arms. They are being constantly moved from post to post, always in readiness for what may happen. The street railways naturally come in for the same sort of treatment as the steam roads, but they are so insignificant in comparison they are not taken into consideration."

"But what of the socialistic contention for municipal ownership, regardless of whether it is practicable or not?"

"The establishment of corporations composed of the people to manage the business interests of this country was one of the first practical steps in establishing a free government—a government of the people, when they could band together to organize manufacturing concerns, transportation companies, and any industries which require large amounts of capital. As the country has grown, the demand and necessity for the enlargement of the powers of corporations has grown also. They are owned by the people, as they should be, and every man or woman who has the ability can be an owner in them.

"I believe there would be no worse blow that could be struck our liberty than to place under municipal or governmental control the transportation and other corporations of this country. It would soon build up a government based upon the tyranny, strength, avarice, and despotism of the head of that government, and the people themselves would have little or no voice in it."

1. Abstract of an interview with Mr. C. T. Yerkes, *Chicago Tribune*.

THE DANGERS OF GUARD WIRES.

IN a recent letter to Mayor Clarke, of Manchester, N. H., on the subject of guard wires, the local street railway having been ordered to string them wherever its trolley wires crossed others, Capt. Wm. Brophy, electrician of the Wire Department of Boston said: Guard wires, when properly installed, do, in a measure, prevent electrical contact between the trolley and other wires, thus preventing danger to fire alarm apparatus, telephones and other instruments, and in that way preventing injury to persons using them, and at the same time reducing the danger from fire. But they are not an absolute safeguard for the following reasons: (1), they are not always properly insulated from the pole and trolley wire; (2), there are not many hours in the day when the trolley does not come off the wire. In such cases, the trolley, span and guard wires are connected electrically through the medium of the trolley pole, thus making the guard wires as dangerous as the trolley itself.

One of the worst burnouts that ever befell the Boston fire alarm telegraph occurred in that way. One of the circuits came in contact with the guard wire at some point of the West End Railway system. The trolley left the wire at some other point, and the pole rested against the trolley and guard wires. As the latter is one continuous unbroken line, current was conveyed to the point where the fire alarm wire was resting on it, and destroyed every instrument on the circuit.

Accidents of this kind to telephone and other circuits are quite frequent.

It is often, as you know, necessary to cut the trolley and

guard wires when they are an obstruction to the fire department. In all such cases the span and guard wires become as dangerous as the trolley; and a very large number of the accidents that have occurred to the members of your department, when on duty, are, as you well know, due to this cause.

I think on the whole the guard wires, as erected at the present time, are often a real source of danger to the firemen and others.

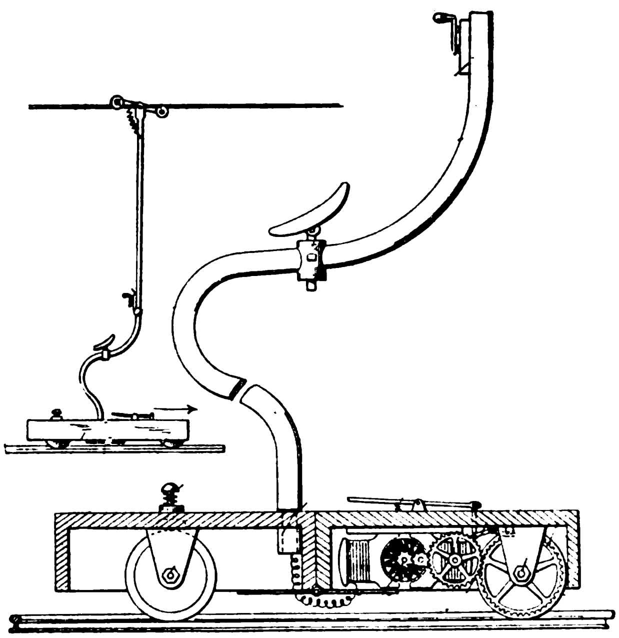
If they are erected, it should be in the following manner: They should be insulated thoroughly from the span wire that supports them, and if iron poles are used, insulated from them also in a most thorough manner. They should be divided up into sections or lengths of 500 or 1,000 feet, and an insulator or circuit-breaker placed between the different sections. These insulators will prevent the flow of current from one to the other.

The trolley wire should be divided up and the sections insulated from each other in the same manner, with a suitable switch at the junction of the connection to connect or separate them. In that case the current should be cut off from one or more sections, and the trolley, guard and span wires cut or handled with perfect safety. The location of these switches should be made known to the chief of the fire department and his assistants, and they should have access to them in case of fire. This will prevent accidents to firemen and others when it is necessary to cut the wires, when they are an obstruction.

Mr. J. H. Bickford, of Salem, Mass., also wrote that guard wires were generally as much a menace as a protection.

THE "PEDO-ELECTRIC" TROLLEY.

The "pedo-electric trolley," as it is called, which has been recently patented by Robert T. Oney of Charleston, West Virginia is designed to run on a single rail and furnish individual trans portation over a trolley line. The car, illustrated in the accompa nying engravings, is small, readily handled, and of single con



THE ONEY PEDO-TROLLEY.

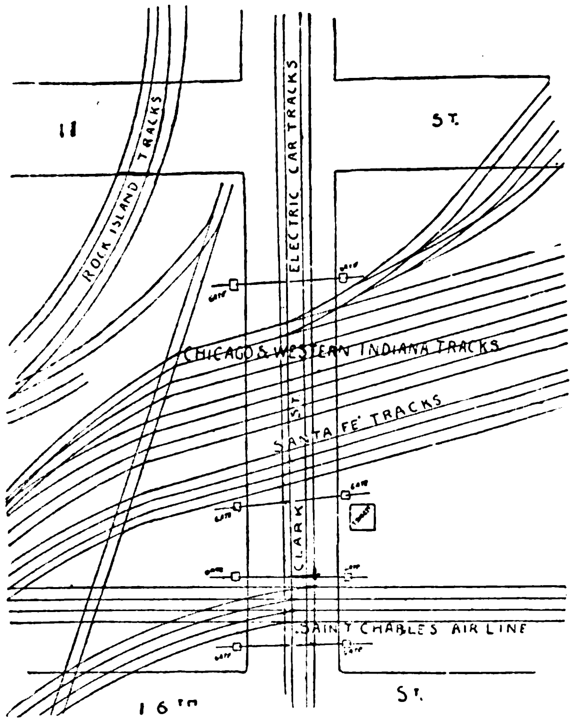
struction, is arranged to accommodate a single passenger, who stands in the rear of the trolley pole, and controls the machine, making it go fast or slow according to his requirements by means of the usual rheostat and a suitable switch and brake.

The carriage consists of two parts, hinged together and having a carrier-wheel on the front and rear axles. The axle of the front carrier-wheel has a gear to which motion is transmitted from the armature shaft of the motor, to which current is led in the ordinary way from the trolley wire. The trolley pole carries an insulated seat or rest for the passenger and insulated handle-bars, near which a rheostat is fixed. The two frame parts of the carriage are made of wood or other insulating material, and the passenger stands with one foot on the forward frame-section and one on the rear, a brake, adjacent to the rear foot being arranged to act on the rear carrier-wheel and a switch lever being so placed that it can be conveniently operated by the forward foot of the passenger, who thus has full control of the current and can regulate the speed of the carriage.

When the carriage is not in use and is to be removed from the rail, the two pivoted frame-sections are closed, and they form a complete inclosing case. The carriage can be so adjusted as to travel only a predetermined distance, and the passenger is thus prevented from riding further than the distance called for by his ticket.

A DANGEROUS TROLLEY CROSSING IN CHICAGO.

NOTE was made in a recent issue of THE ELECTRICAL ENGINEER, as to the intolerable delays experienced by street car lines crossing steam tracks in Chicago. The accompanying cut brings out very



CLARK STREET TROLLEY CROSSING, CHICAGO.

clearly the other element of danger. How it is possible to operate a trolley road in safety and on schedule, under such conditions, it is hard to imagine; and it would seem that every argument would demand a change. This is the crossing which was made the subject of a special message by Mayor Swift to the Chicago City Council recently, in which he recommended all trains be made to come to a full stop before crossing Clark street. It is by all odds the most dangerous crossing in the city. Railway men whose roads do not use it say they know of no other like it anywhere. Running diagonally across Clark street at the intersection of Sixteenth are two tracks of the Atchison, Topeka and Santa Fé and four of the Western Indiana. Over these every train running in and out of the Dearborn street passenger station must pass, and all the empty coaches, sleeping, dining, mail, baggage, and express cars must be switched, going to and coming from the yards. There is no yard room for their accommodation between Sixteenth street and the station.

THE TROLLEY AS A GARBAGE CART.

The idea advanced by Mr. Lewis Stockton that the new street railway company, if granted a franchise, give the city of Buffalo the privilege of using its tracks between midnight and 6 A. M. for transporting garbage and ashes is not a bad one. It has been urged before that it would be advantageous if the garbage and ashes could be brought to stations located in different parts of the city, and from them transported on cars over the trolley lines to the places where the city's refuse is disposed of. The collection of the garbage and ashes could be made much more quickly under such a system and with less annoyance to the public. Of course a considerable saving in the expense of collection could be effected if the city were to have the free use of tracks for this purpose. Traffic need not be in any way impeded if the garbage cars were operated only at the time of night when there is a long interval between the running of passenger cars.

THE "LITTLE CONSOLIDATED" RAILWAY CO., of Cleveland, is putting in a 1000 H. P. Elwell-Parker generator to be driven by a Globe Iron Works engine.

THE LOWELL & SUBURBAN STREET RAILWAY is preparing plans for an addition to its plant of 2000 H. P. in boilers, engines, and generators.

A 24-FT. PLATE-STEEL FLY-WHEEL.

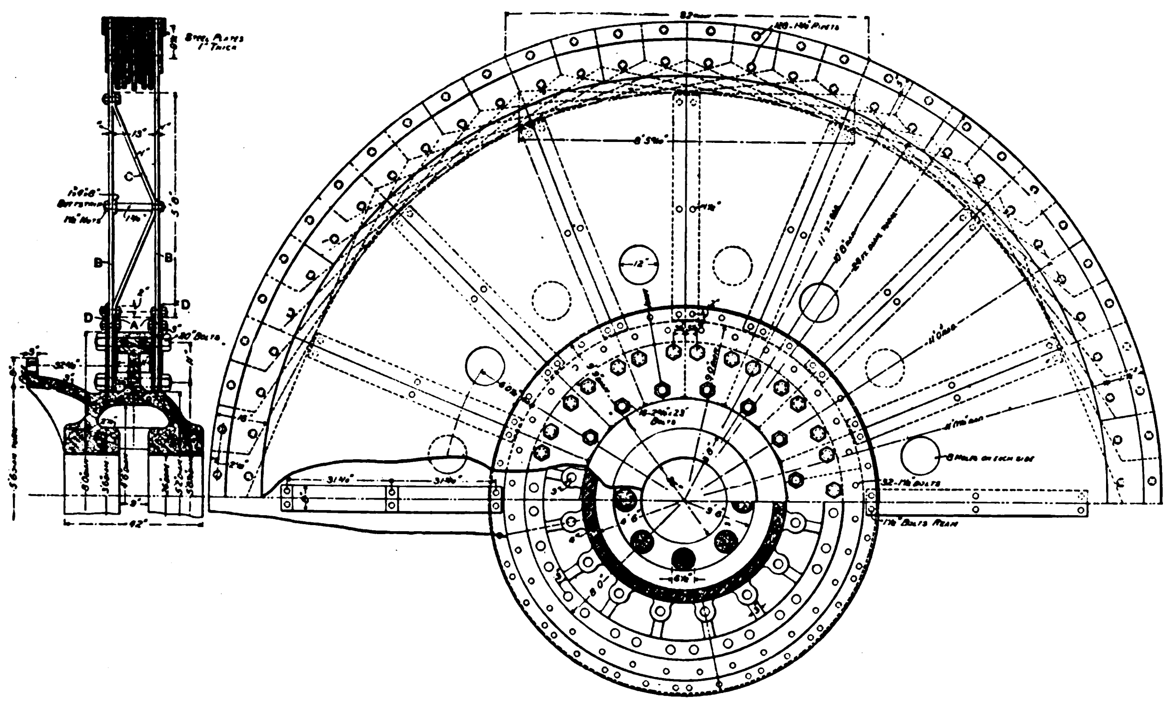
THE constantly recurring accidents with cast iron fly-wheels even when built up has led many engineers to seriously consider their abandonment for heavy work, and to substitute for them wheels built up entirely of wrought iron or steel. The latest example of this kind is a wheel built by the E. P. Allis Company, of Milwaukee, illustrated in the accompanying engravings, for which we are indebted to the *Railroad Gazette.* This wheel is built of plate-steel, 24 feet in diameter and is intended to be attached to a 32 x 62 x 60 in. cross-compound engine, directly connected to a General Electric generator, for the West End Street Railway Co., Boston.

This is a departure from the ordinary fly-wheel construction which consists in casting the wheels in segments and bolting these together. In this wheel there are no internal strains to weaken it such as might occur in cast wheels. This in connection with other features of construction will permit greater velocity of rim than in wheels built up of cast segments and spokes bolted together. The speed at which this wheel is intended to run is 75 revolutions a minute, giving a speed at the circumference of 90 ft. a second or a little over a mile a minute. The weight is distributed as follows:

Centre	33,000	pounds.
Web plates	47,700	"
Rim	69,300	"
Total	150,000	"

Fig. 1 is a side elevation of half the wheel and a longitudinal section through half the hub, while Fig. 2 is a transverse section of half the wheel. The hub is made of cast-iron, and is 8 ft. extreme diameter. Surrounding this hub are two plates, A, Fig. 2, which are split on the diameter as shown in Fig. 1. These plates are of steel 1 in. in thickness and 23 in. wide. From these plates extend the web plates, 16 in number, to the extreme outside diameter of the wheel. These plates, D, Fig. 2, are also 1 in. in thickness and are faced along the edges so as to form a good joint. Between those on the opposite sides of the hub are 1 in. by 8 in. truss pieces C, Fig. 2, bolted at the ends with two ⅞-in. bolts, and having at the centre two 1¾ in. bolts to act as struts. These bolts are turned down to 1⅛ in. on the ends. These truss pieces are put at the joints between the web plates. Outside of the web plates are two cover plates, D, Fig. 2, 1 in. in thickness and 27⅛ in. wide, which are also split on the diameter as plates marked *A*. Through the outside cover plates D, web plates B. and inside plates A, are 40, 2¾-in. bolts spaced so that three of them will come on each segmental web plate. Besides these bolts there are 48, 1⅛-in. bolts on each side through the cover and web plates. The section of the rim between the web plates consists of, 18 1-in. steel plates placed side by side and joining on the ends as shown in Fig. 1. The joints of these plates overlap as shown in Fig. 1, each plate covering seven joints of the others. Outside of the web plates on each side the rim are 1 in. x 12 in. plates forming a cover around the entire rim; this cover is made up of eight pieces. Still outside of this is another strip 1 in. x 5 in. also extending all the way round the wheel. 1¾-in. rivets hold the plates and the rim together. They are countersunk as shown in Fig. 2.

By this construction the increased strain on the rim between spokes is avoided, the web plates forming, as it were, an infinite number of spokes. Other details and dimensions are completely given in the accompanying engravings.



FIGS. 1 AND 2.—A 24-FT. PLATE-STEEL FLY-WHEEL.

THREE CENTS FOR STANDING UP.

According to recent announcement, there appears to be a compromise idea, says the *Jersey City Journal*, on the street car controversy in the city of Chicago, in which there is possibly a modicum of sense. The suggestion for this comes in the form of a proposition that the fares be reduced to three cents in cases where the passengers cannot get seats, and a resolution introduced at the city council's last meeting, provides that "all street railroad companies be required to charge not more than three cents fare when no seat is furnished, and in no case to charge more than five cents when a seat is furnished. It also provides that a passenger having paid a three-cent fare for standing room, can if a seat be subsequently vacated, occupy the same without paying additional fare." Now, while the first part of the proposition may have some measure of sense in it, the second part certainly has not, for the simple reason that it is not exactly fair that a man who has paid for a stand-up only, should receive a seat which is worth two cents more than the amount which he has paid. We very much doubt if the three-cent fare idea will actually prevail for many days yet to come. Certainly a mix-up of the kind proposed for Chicago will not be a smooth working arrangement. And yet there is force in the suggestion that a ride without a seat may reasonably be deemed worth less than a ride which includes one.

REWARDS FOR PHILADELPHIA TROLLEY MEN.

The Directors of the Hestonville, Mantua and Fairmount Passenger Railway Company gave $2,500 to its employés on Dec. 24, for the fidelity and ability displayed during the recent strike. The Hestonville Company is the only line in Philadelphia not embraced in the Union Traction system, and while the strike of the latter company's employés was in progress it was the only street-car line that was operated regularly. As a consequence, the traffic was very heavy. There are 300 men in the employ of the company.

THE LONG ISLAND TRACTION CO.'s properties were sold last week for $5,500,000 to John G. Jenkins, president of the First National Bank of Brooklyn, a member of the Reorganization Committee. The capital of the road is $30,000,000, which it is proposed to reduce to $20,000,000. The new company will be called the Brooklyn Rapid Transit Co.

STEAM AND TROLLEY IN CONNECTICUT.

An interesting situation which may soon develop some acute steam-trolley rivalries, exists between Hartford and New Britain, two cities eight miles apart, and the latter with a population of some 22,000. In Hartford and neighborhood are street railway trolley systems with some seventy miles of track to a considerable extent paralleling the New Haven and New England steam roads. New Britain has in the city and neighborhood about twenty miles of trolley track paralleling for about nine miles the New Haven and New England Roads and chiefly controlled by the New Britain Central Railway and Electric Company. The New Britain and Hartford trolley systems have, however, not thus far been connected, owing partly to an impeding decision of the courts, and partly to the refusal of the New Britain city government to allow a certain street to be used unless the local trolley company submits to city taxation. Pending further decisions of the court the New Britain Company has surveyed a line to Hartford, and, should it win in the legal contest, will immediately connect the two cities and compete between them with both the New Haven and New England steam companies.

Since the New Haven secured control of the New England, the interests of the two steam companies are practically identical. Starting at a point only about a mile from New Britain, they have four tracks running to Hartford side by side. A short double track spur will give them four tracks between the stations of the two cities. It is known that the New Haven Company contemplates, should the New Britain Trolley Company succeed in getting through its line, the equipment with electricity of two of the four tracks and putting on what would be in effect a trolley express service, operated at short intervals between the two cities. The legal questions involved must soon be settled by the Supreme Court of the state, and a decision of the local tax case is expected in a very few days. Should the trolley company win, prompt action by the New Haven Company to thwart, if possible, its trolley rival is almost certain to follow. Its contingent design of using two of the four tracks for trolley service is analogous to that heretofore planned in connection with its four tracks into Boston.

ELECTRICITY FOR A STEAM ROAD IN MAINE.

The Norway & South Paris Electric Street Railway Company, Maine, has chosen a committee consisting of Hon. H. L. Shepherd of Rockland and Gen. George L. Beal of Norway to confer with the officials of the Grand Trunk about operating the branch railroad from South Paris to Norway by electricity in the place of steam. The plan proposed is to run the cars on the branch with an electric motor and to dispense entirely with the steam engine now used. The company propose to haul the freight cars by electric power over the branch to the present station. A part of the passenger traffic may come the same way and the road be extended from the station through Cottage street to Main street where it will connect with the present electric railway forming a belt line between the two cities. The larger portion of the passenger traffic and the mail and express will be conveyed over the street route now running. This may be the first place in Maine to run freight and passenger cars by electricity over a road built for steam driven cars.

REWARDS AT WESTPORT, CONN.

Sixteen conductors and as many motormen have received cash prizes for good work, at Westport, Conn., the sums ranging from $5 up to $25. The men have won the prizes by freedom from accidents, excellent handling of cars, running on schedule time, neatness, cleanliness and courtesy to the public.

CAR GATES UNCONSTITUTIONAL IN MISSOURI.

Judge Burgess, of the Supreme Court of Missouri, has ruled that the State law requiring street railway companies to protect the front platforms of their cars with gates or guards, is unconstitutional. The decision is based upon a clause in the State Constitution requiring that all matter contained in the act itself must be embodied in the title to the act. The idea of this is that when a law is passed anyone may know by reading the title just what is contained in the act itself. It has been found that in the law requiring gates on the front platforms there were a number of things treated of in the body of the bill to which no reference was made in the title.

President Baumhoff of the Lindell railway says that the decision will not in any way affect the conduct of the companies.

"We have always had gates on the front platforms of our cars," he said, "and intend to have them right along for our own convenience and protection. We always held that the law did not apply to the front platforms of trail cars. Our claim was that the law referred only to the front platforms of motor cars. I think every railroad in this city so regarded it, but many of them voluntarily put gates on the front platforms of trailers. We are not anxious to injure people at all, as it is generally very expensive, but we did hold that the law referred to was unconstitutional and it was fought on that ground. All roads, I fancy, will go on just as they have. The only difference will be in our liability for injuries."

BUFFALO TRACTION CO.'S PLANS.

"If we get a franchise," says John K. Page of the Buffalo Traction Company, "we shall put on 200 trolley cars at the first crack. We shall order 125 closed cars and 75 open cars, and they'll be ready as soon as the road is ready to be operated. The cars will be similar to those on the Broadway line in New York City—the best type of the Stephenson make. We'd order more cars, but the builders told us they couldn't possibly supply us with more than 200 in one year."

"SMOKER" TROLLEY CARS IN JERSEY.

The Consolidated Traction Company, of Jersey City, is considering the plan of running combination express and smoking cars. The forward part of the new car will be for the smokers and the latter part for the conveyance of parcels. "Of course," said Mr. Young, recently, "we cannot carry big stuff, and even the question of freight carrying is being bitterly contested in Newark. But as soon as that trouble is settled, and we expect it will be adjusted soon, then we will run these combination cars. It will be a great convenience for business people if they want to —say, ship parcels from Jersey City to the Oranges or Bayonne. We, of course, cannot deliver the parcels from door to door, but some express company will doubtless take this in hand and ship their packages at our depot, and at the end of the line deliver them. Just as soon as we can settle this matter of running express cars we will accommodate the smokers at the same time."

STREET TROLLEY CARS PROPOSED ON BROOKLYN BRIDGE.

The Nassau Electric Railway Co. seeks to secure the exclusive privilege of running trolley cars over the bridge from Brooklyn to New York, and says it can handle 40,000 persons in this way in an hour, besides rendering the trip easy and comfortable.

TO SELL MILWAUKEE STREET LINES.

Judge Jenkins has signed a decree of sale in the foreclosure proceedings against the Milwaukee Street Railway Company. The plaintiffs to this action are the Central Trust Company, New York; the North American Company, Nelson Robinson, and the Milwaukee Street Railway Company of New Jersey. F. M. Hoyt is appointed special master to carry the decree into effect. The amount of the consolidated mortgage to be forclosed is $8,906,000 with interest due, and on which default was made, $9,425,292 64, bringing the amount down to Dec. 19, 1895. The road must be sold to the highest bidder in the hall of the courthouse, the date and hour to be fixed by the master.

PITTSBURGH STREET RAILWAY CONSOLIDATION.

The Pittsburgh Traction Company, the Duquesne Traction Company and the Central Traction Company are now practically part of the Consolidated Traction Company. The stockholders of the three corporations have voted to lease their properties to the Consolidated Company for a period of 950 years. The consideration aggregates an annual rental of $340,000. The total capitalization reaches about $20,000,000.

ELECTRIC RAILWAY WORK IN IOWA.

The Waterloo & Cedar Falls Rapid Transit Co., per J. H. Rafferty, writes:

We expect to be in a position to entertain propositions from electrical engineers and contractors within a short time. On account of the heavy snow during the winter in this section of the country, we think it advisable that engineers and contractors see this ground before snow falls. We expect to commence the construction of this work as early as the weather will permit us in the spring. We expect to construct about fifteen miles of road.

MR. LEVI PERKINS, president of the Holyoke, Mass., Street Railway Co. is dead, at the age 64.

MAYOR PINGREE of Detroit is proposed as head of a big national association "to fight the encroachment of street car corporations." This ought to be the kind of gubernatorial or presidential boom he is after.

LOWELL TO LYNN.—Trolley cars are now running on regular schedule between Lowell and Lynn, a distance of 26 miles making the trip in about $2\frac{1}{2}$ hours, and apparently finding plenty of patronage along the route.

TELEPHONY AND TELEGRAPHY.

LEGAL ASPECT OF THE TELEGRAPH AND TELEPHONE SERVICE.[1]

BY WALTER CLARK, Judge, Supreme Court of North Carolina.

THE author begins by asserting that it is unconstitutional for the telegraph and telephone services of the postal system to be operated by a private monopoly, or in any other manner than by the Government. He adds:

"When the Constitution placed the postoffice in the hands of the Government it conferred exclusive operation, and with it all means of operating it to the best advantage. The same clause of the constitution of the United States (Art. 1, sec. 8) which empowers Congress to declare war, raise and support armies and a navy, to coin money, regulate commerce, and borrow money on the credit of the United States, includes the provision to "establish postoffices and post roads." If the power of the Government is exclusive as to the other provisions it is so also as to the postoffice, for all these powers are conferred by the same clause and by the same words—in one breath as it were. The numerous decisions of the United States Supreme Court holding the power of Congress over the postoffice and the carrying of mails to be exclusive, render unnecessary any discussion of an undisputed point. It is interesting to note, however, that in 1886, the Hon. John C. Calhoun, the leader of the strictest constructionists, who denied to the general Government all powers not clearly granted, in a report made by him as chairman of a committee of the United States Senate, said: "It must be borne in mind that the power of Congress over the post-office and the mail is an exclusive power." These words have been cited and approved by the Supreme Court of the United States in the case of ex-parte Jackson so recently as the 96 United States Reports on page 734. The bestowal of the exclusive right and duty to operate the post-office carried with it the exclusive right and duty to use all the agencies that would make the post-office most highly efficient, as such agencies from time to time should be improved or invented. On this principle the first telegraph line was built by a Congressional appropriation under a "strict construction" administration (Polk's), and the telegraph belonged to the Government, 1844–47; and when under mistaken notions of economy it was then turned over to private ownership, Henry Clay, the great Whig leader, and Cave Johnson, the Democratic postmaster general, were among the public men who went on record as earnestly protesting against such a step. Indeed the Supreme Court of the United States in a unanimous opinion (Pensacola vs. Tel. Co. 96 U. S. 1) has held that the telegraph came within the grant of power to establish the postoffice."

Justice Clark holds that the postoffice is as exclusively a Governmental function as the army or navy, or the department of justice. Yet the Government operates only the slow, antiquated non-paying part of the postoffice, leaving the taxpayers to make up an annual deficit of six or eight millions; while the improved, up-to-date part of the postoffice, the rapid or electric mail (the telegraph) is operated by a private monopoly and pays a heavy dividend on its watered stock of one hundred and fifty millions—ten times the actual value of its plant. With wire costing less than $10 per mile there is no reason, he alleges, why the Government should not own a line to every postoffice in the Union.

1. *December "Arena."*

PAYING TAXES ON ERIE TELEPHONE SUB-CO. STOCK.

The commissioners have given their decision in the famous Erie telephone tax case which has been pending for five or six years. The petition was for abatement of taxes assessed on Messrs. Charles E. Adams, J. W. C. Pickering, Levi Sprague, A. C. Russell, Francis Jewett, Charles J. Glidden and J. W. Bennett, all of whom were Erie directors in 1889, the time to which the petition applies.

The commissioners' decision is against the petitioners and this means that they will each have to pay the sum of $2,576, making a total of $18,032, unless the superior court to which they will probably take the case decides otherwise. The petitioners held in trust the stock of the various sub-companies in which the Erie holds a controlling interest.

In 1889 the assessors decided to assess each of the seven directors for one-seventh of the stock held by them in trust. The amount of the tax thus assessed was $2,576 each, or a total of $18,032. The assessors at the same time refused to accept the stock in the Erie Company held by the men in question.

Thinking that the assessment upon the stock of the sub-companies was unjust, the seven directors refused to pay it. They contended that the stock assessed was of no value except that it served as the basis of the Erie Company; and also, as the plants of the various sub-companies were taxed in the state in which they are situated, that they should not be subjected to double taxation. As the directors refused to pay the tax, the assessors proceeded to attempt to collect it. Only the tax for 1889 is involved, as since that time the directors of the Erie have each paid a tax upon one share of the sub-companies and their Erie stock has been accepted for assessment.

TELEPHONES FOR THE BROOKLYN BRIDGE CARS.

TELEPHONES are already in use on many trolley lines and they are now proposed for the cars of the New York and Brooklyn Bridge as a means of preventing accidents, especially in foggy weather, such as that of Nov. 19, when two men were killed by the collision of two trains. Assistant Engineer Kingsley L. Martin, a son of Chief Engineer and Superintendent C. C. Martin, has been experimenting with the telephones on the cars, and has come to the conclusion that the idea is feasible. Mr. Martin will experiment hereafter with a metallic circuit, which he thinks will give much better results than a circuit grounded on the trucks of the cars.

The plan Mr. Martin expects to make perfect will keep the train dispatcher in constant communication with the conductors of all trains on the bridge, and make a collision almost an impossibility. The train dispatcher will sit in his office and will have fastened to his ear at all times a telephone receiver. This will leave him the free use of his hands with which to operate the bells, &c. In front of him will be a switchboard, with signal bells, and a long-distance transmitter. There will also be in front of him the starter's gong, engine-room signals, and call bells.

On the end of the trains will be placed a head telephone and transmitter. The transmitter will be arranged directly in front of the brake-wheel, so that the conductor may use the brake and talk through the transmitter at the same time. In case anything goes wrong, the conductor will simply have to speak into the transmitter and the train dispatcher, wearing the head telephone, will know instantly what is wrong, and will be able to communicate to the trains in the rear.

When the dispatcher wishes to talk to a conductor he will ring the bell, the conductor will pick up the receiver which will be at hand, and then the dispatcher will call the name of the trainman that he has in view, and the others will simply hang up their transmitters for future use.

The benefit of the telephone in foggy weather is apparent, and at such times, in order not to lose a second's time, the conductors will all wear head telephones, so that the train dispatcher will not have to ring. He will simply give his instructions through the transmitter, and every conductor at work will hear what he has to say.

Mr. Martin, in his experiments, has used the long-distance wall telephones, and the current was obtained from the electric trolley wires now in use. While the car was standing in the station, a communication was easily obtained, and when in motion conversation could be conducted on the way to New York.

TELEPHONE POLE RIGHTS IN DAYTON, O.

A special dispatch from Dayton of Dec. 22 says:—The Central Union Telephone Company received a severe blow here yesterday, when the Circuit Court decided that it had no right in the streets or alleys with its poles and wires, and issued an order of ouster. The company had a franchise for ten years, and neglected to have the franchise renewed. For two years it had no franchise, but no one molested or disputed its right to the streets until a rival company came here and applied for a franchise.

THE NEW PACIFIC CABLE PLANS.

With regard to the plans of the new Pacific Cable Co., already noted, ex-mayor Hewitt, one of the largest shareholders says:—"The Government of Hawaii has granted to Col. Spaulding, a well-known planter of the Hawaiian Island, a concession for a cable to the United States, with a subsidy of $40,000 a year. Col. Spaulding came to New York for the purpose of forming a company to lay the cable, but a subsidy of $40,000 a year is certainly inadequate to pay the interest on the outlay and expense for maintenance, which it is estimated will be about $800,000 a year. In the last Congress a bill was introduced and passed by the Senate, authorizing the President to contract for a cable to the Hawaiian Islands at a cost not to exceed three millions of dollars. The bill failed in the House, where it was thought that a corporation would be a better agency for securing a cable, because for commercial and general purposes Government ownership and general management are not desirable.

"Col. Spaulding's idea is to apply to the Government of the United States for a sufficient subsidy to warrant the laying of the cable and for its maintenance. As the enterprise is of great public and commercial importance, several prominent gentlemen have agreed to co-operate with Col. Spaulding and to furnish the money required, provided the subsidy is secured. Their object, however, is not to make any money out of the enterprise, and hence, in the bill which will be presented to Congress, provision is made that the United States Government may at any time

release itself from the subsidy by taking the cable from the company at the actual cost of construction.

"In other words, the object of these gentlemen is to secure to the United States the advantages of cable communication with the Hawaiian Islands, in the hope that the cable at some future time may be extended to Australia and China, with which countries we have large and growing commercial relations."

WESTERN UNION CONDUITS FOR KANSAS CITY, MO.

The Western Union Telegraph Company's Manager, at Kansas City, Mo., Mr. M. D. Wood, has asked that the public improvements committee of the lower house act on a separate ordinance introduced for the Western Union over a year ago.

The Western Union wires are concentrated in a small portion of the city and the company does not wish to build over two miles of conduit. It asks, however, that it be given a separate conduit. The substitute for the Western Union company's old conduit ordinance provides that the company can be compelled by the city to rent portions of its conduit to other telegraph companies, and reserve one duct for the city. Of the money derived from rentals, 10 per cent. is to go to the city, which is also to receive twenty cents a year for every yard of conduit as rental. There has never yet been offered to the council a valid reason why all electric wires of the same class should not use the same conduit. Separate manholes are given in some places, so that workmen of one company cannot disturb what belongs to another company.

PROBABLE SALE OF THE B. & O. WESTERN UNION STOCK.

When Mr. Jay Gould absorbed the Baltimore & Ohio Telegraph service, a large amount of Western Union stock was issued for the purchase. It is now said that there is a likelihood of the stock coming on the market, the condition of the B. & O. being said to require a realization upon the property, as it can use the money to advantage for extensions of its railway lines and the lifting of debt. Last week, the general uneasiness caused by Mr. Cleveland's Venezuelan pronunciamento, was added to by sharp declines in Western Union and Baltimore and Ohio. Officers of the latter company attributed the decline in its stock to a bear attack, but as there were only 1,870 shares traded this seems hardly probable. The stock broke from 40½ to 33, a net loss of 7½ points Being without support, the attempt of a few individual holders to liquidate in view of the very bearish rumors concerning the financial condition of the property, is quite sufficient explanation of the decline. Western Union's decline of 3⅝ points was accompanied by a rumor that the Baltimore and Ohio was marketing some of its holdings of 40,000 shares. Officers of the Baltimore and Ohio were emphatic in denying the rumor, adding that not a single share had been disposed of. At the same time, reports of an impending default by the Baltimore and Ohio were denied.

NEWS AND NOTES.

THE NATIONAL ELECTRICAL EXPOSITION.

Mr. Clarence E. Stump, who is so well known in the electrical field, has been appointed General Manager of the Electrical Exposition which is to be held in New York City, beginning May 4th and continuing until the first of June.

Numerous inquiries for information regarding space and other details are being daily received by the management, and a large number of prominent manufacturers have already closed contracts, while many additional firms have signified their intention to make extensive exhibits. The success of the enterprise is assured, and all indications point to the largest and most interesting display of electrical apparatus and supplies ever made in this country.

ELECTRICAL WORK AT PEORIA, ILL.

The directors of the Central Ry. Co. held an important meeting and decided to increase the capital stock from $600,000 to $750,000. The increase is to be divided pro rata among the stockholders if they so desire it. It has also been decided to issue bonds to the amount of $750,000, of which $500,000 will be disposed of immediately and the remainder sold as occasion may require for the betterment of the road.

The system is now bonded to the extent of $300,000, the first mortgage bonds being for $200,000 and the second for $100,000, both bearing 5 per cent. interest.

The new bonds will draw 6 per cent. interest and it is thought that the stockholders will take them pro rata. The first and second mortgages can be taken up at any time and it is the purpose to take them up and wipe out the old indebtedness and leave the balance for improvements.

The old Fort Clarke power house has been abandoned and the boilers and machinery removed to the Central Ry. Co.'s power house, which is now furnishing power for all the lines.

The Board of Park Commissioners have decided to put an electric light plant of their own in Glen Oak Park, as they find it will be much cheaper than to rent the lights from the Péoria General Electric Co.

MATERIAL FOR INCANDESCENT CONDUCTORS.

A recent invention of Dr. Ludwig K. Böhm, of New York, N. Y., has for its object the improvement of filaments for incandescent lamps. Heretofore the material generally used for filaments has been carbon, usually of the highest degree of purity obtainable. In Dr. Böhm's invention, the carbon instead of being pure is combined with calcium. The resultant carbide of calcium has sufficient electrical conductivity to render it a suitable and efficient material for incandescent conductors, and furthermore possesses the advantage of higher specific resistance than pure carbon.

HONEY IN AN ELECTRIC LIGHT GLOBE.

For some time the electric light globe in Monument Square, New Brunswick, N. J., has been in disuse, and on Dec. 24, Frank Boudinot, a lineman, went to repair it. When he got up to remove the globe he was attacked by a swarm of bees that had taken possession of the globe as a hive, and was severly stung before he could escape. Afterward the bees were smoked out, and the globe was found to be more than half full of honey.

CLEAN RECORDS FOR MOTORMEN.

One year ago the Steinway Trolley Company of Long Island City, posted a notice stating that any man running his car for one year without an accident would receive $25 as a Christmas present. Dec. 24 was the time for making the presents, and ninety-eight men received the full amount. There were ninety-four men who had not been in the employ of the company for a year, and they recived amounts in proportion to their term of service. It took over $4,000 to make the presents, but the officers of the company feel fully repaid for their gifts to their employees.

HOLLIS PREFERS THE CURFEW.

The other day a proposal was made at a parish meeting for the lighting of the village of Godshill, Isle of Wight, with eight lamps, which, it seems, could be maintained at the modest cost of a halfpenny rate once every three years. Up rose a farmer named Hollis to oppose the revolutionary scheme. To the mind of this worthy English rustic, its authors were "wanting to turn night into day." "It would set a bad example to the young," he continued, "keeping them out all hours of the night. What they ought to do was to set a good example by going to bed early and getting up early, and he would like to hear the curfew rung again."

THE CHRISTMAS STORM IN INDIANAPOLIS.

A special dispatch of Dec. 26 from Indianapolis, Ind., says: A blizzard has prevailed in this city from early this morning. The streets at noon were almost impassible, and the telephone and electric light wires were in a tangled mass. Not a telephone is in working order. One horse was killed, and several persons rendered insensible by coming in contact with "live" electric wires. Gangs of men are at work trying to get the wires off the streets, but the storm is increasing in force, and work progresses slowly.

ELECTRICAL PROVIDENCE.

The Providence, R. I., *Telegram* has just issued a very handsome Christmas week edition. Part of its space is devoted to an account of the leading industries of the city, and we are glad to note that the American Electrical Works and the Armington & Sims Engine Co. come in for very full treatment, as they deserve. The growth of such notable industries has done much to assist in the promotion of the prosperity of Providence, as well as to render electrical work safer and more efficient. There are illustrated articles also on the Providence Telephone Exchange and the Pawtucket and Narragansett Electric Light Companies, and the Union Traction Company. The *Telegram* is to be congratulated upon its success and upon the energy that characterizes its management.

THE VANITY OF CONGRESSMEN.

Some of the Congressmen do not like the new electric method of calling pages by pressing a button; the old way of clapping hands attracts more attention from the galleries.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS ISSUED DEC. 17, 1895.

Accumulators :—

Process for Renovating Storage Batteries, J. Trowbridge, Cambridge, Mass., 551,565. Filed Oct. 1, 1895.
To reduce the sulphate the negatives are temporarily removed and zinc plates substituted.

Conductors, Conduits and Insulators :—

Cable Hanger, S. S. Leonard, Chicago, Ill., 551,504. Filed Aug. 8, 1895.

Dynamos and Motors :—

Electric Motor, M. J. Wightman and O. C. G. Urban, Cleveland, O., 551,567. Filed May 16, 1895.
An electric motor having a pole piece constructed in two sections; the rearward or outer section is removable whereby the inner section is capable of being moved outwardly or backwardly from the armature.
Dynamo Electric Machine, A. B. Blackburn and W. Buchanan, Wolverhampton, Eng., 551,712. Filed Oct. 1, 1895.
Details relating to construction of laminated fields of a self exciting alternating machine of the inductor type.

Electrometallurgy :—

Apparatus for Manufacturing White Lead by Electrolysis, A. B. Browne, Cambridge, and E. D. Chaplin, Natick, Mass., 551,361. Filed July 2, 1894.
Details of construction for electrolyzing lead in nitrate of soda.
Art of Producing Carbide of Calcium, W. C. Clarke, New York, 551,461. Filed Apl. 29, 1895.
Arranged so that at the end of the process the body of carbide is surrounded by an undecomposed mass of the mixture of lime and carbon.
Electrolytic Process of Obtaining Precious Metals, L. Pelatan, Paris, France, and F. Clerici, Milan, Italy, 551,648. Filed June 25, 1895.
The cathodes rest on the bottom of the vat. The anodes are revolving cylinders with anode plates between each group.

Lamps and Appurtenances :—

Incandescent Electric Lamp, C. A. Beal, Abington, Mass., 551,357. Filed Feb. 28, 1895.
Relates to the construction of socket for a double filament lamp.
Magnetic Electric Lamp Holder, M. H. Collom, Denver, Colo., 551,364. Filed June 12, 1895.
A magnet is attached to the socket so that the lamp can be suspended from any part of an iron structure.
Electric Light, D. Misell, New York, 551,394. Filed Apl. 5, 1895.
A table lamp with battery, and mechanism for breaking the circuit intermittently.

Measurement :—

Electric Meter, T. Duncan, Ft. Wayne, Ind., 551,486. Filed July 11, 1895.
An improved induction motor meter in which the losses due to the series coil is reduced, the torque increased and the humming noise avoided.

Miscellaneous :—

Heat Regulator, W. W. Wilcox, Westerly, R. I., 551,497. Filed April 6, 1895.
A damper regulator operated by a thermostat. The movements of the damper are effected by water acting upon a tipping pan, and the flow is controlled by a valve operated by the thermostat and a magnet in its circuit.
Electric Lighter, H. E. Rider and J. Hencken, New York, 551,451. Filed Nov. 10, 1894.
A torch is lighted by a spark from induction coils, by the act of removing the torch.
Electric Lock, P. and J. A. Meyer, Newark, N. J., 551,682. Filed Feb. 23, 1895.

Railways and Appliances :—

Closed Conduit Electric Railway System, F. C. Esmond, Brooklyn, N. Y., 551,584. Filed April 12, 1895.
Details referring to a system in which the live conductor is switched into the car current by electro-magnetic switches as the car passes over each section.
Closed Conduit Railway System, F. C. Esmond, Brooklyn, N. Y., 551,585. Filed Apl. 12, 1895.
Similar above.
Closed Conduit Electric Railway System, F. C. Esmond, Brooklyn, N. Y., 551,586. Filed Apl. 26, 1895.
Similar to above.
Closed Conduit System for Electric Railways, F. E. Esmond, Brooklyn, N. Y., 551,587. Filed Sept. 11, 1895.
Similar to above.
Electric Railway, R. M. Hunter, Philadelphia, Pa., 551,587. Filed Feb. 23, 1887.
Relates to a construction in which the armature is mounted directly on the axle.
Electric Railway Motor Shield, I. F. Baker, W. R. McLain, Lynn, Mass., 551,664. Filed Nov. 25, 1889.
A shield interposed between the motor and the ground for the purpose of intercepting bits of magnetic material attracted from the ground.
Transmission of Electricity to Moving Cars, T. Nesom, Indianapolis, Ind., 551,784. Filed Sept. 21, 1894.
A surface conduit system in which contact is made by magnets attracting the conductor.

Regulation :—

Means for Operating and Regulating Speed of Electric Motors, R. Eickemeyer, Yonkers, N. Y., 551,371. Filed Dec. 31, 1892.
The independent exciting current is generated by a governing dynamo, which is driven by a reversible motor in either direction, and a switching mechanism provides for not only controlling the motor circuit but also for appropriately controlling separate divisions of the field in the governing dynamo, and also controlling its armature circuit, which includes the governing field coils in the motor.
Controlling Electric Motors, D. Mason, Schenectady, N. Y., 551,470. Filed Apl. 22, 1892.
A method of connecting several motors, using one as a starter.
Electric Motor, F. E. Herdman, Winnetka, Ill., 551,633. Filed Aug. 6, 1894.
Device for increasing or decreasing the field current.
Mechanism for Admission and Regulation of Currents to Motors, F. E. Herdman, Winnetka, Ill., 551,634. Filed Mch. 29, 1895.
Similar to above.
Mechanism for Admission of Currents to Motors and Regulation of Currents in Same, F. E. Herdman, Winnetka, Ill., 551,685. Filed June 28, 1895.
Similar to above.
System for Regulating Effective Tension of Electrical Circuits, H. O. W. J. Breul, Berlin, Germany, 551,743. Filed Nov. 17, 1893.
Means for increasing or decreasing the electromotive force impressed upon the several feeding conductors, and a device responsive to the reversal of current in a feeding conductor.

Switches, Cut-Outs, etc.:—

Strong Current Protector, A. L. Joynes, Paducah, Ky., 551,388. Filed Jan. 9, 1895.
The device opens the line wire and ground return in telephone exchanges.

Telegraphs :—

Teletyper, C. Spiro, New York, 551,515. Filed Aug. 14, 1895.
The improvement is in the form of an attachment, which may be readily applied to any type-writers already in use.

Telephones :—

Automatic Telephone Exchange System, W. F. Lounsbury, Oswego, N. Y., 551,391. Filed April 23, 1895.
The connections are effected by magnets which shift from one subscriber to the other.
Holder for Telephone Receivers, F. W. Martland, Fall River, Mass., 551,551. Filed June 10, 1895.
Telephone Transmitter, T. Grissinger, Mechanicsburg, Pa., 551,674. Filed Oct. 18, 1894.
A granulated carbon transmitter provided with a vibrator to prevent the granules from packing.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS ISSUED DEC. 24, 1895.

Alarms and Signals :—

Electric Latch Apparatus for Semi-Automatic Operation of Railroad Signals, H. C. Barnes, and W. W. Slater, Oakland, Cal., 551,942. Filed March 21, 1895.
Electric Signal, E. M. Phelps and A. T. Sampson, Lynn, Mass., 551,998. Filed Oct. 8, 1891.
The combination of a trolley wire and electromagnet in circuit therewith, an armature arranged to be moved within the field of the magnet by the trolley and to close the circuit through the magnet to hold it attracted, a signal in circuit with the magnet and a circuit breaker for breaking the circuit.
Electrical Switch Operating and Signal Apparatus, J. Dutrey, New Orleans, La., 552,053. Filed May 25, 1895.
Circuit Closer and Breaker, J. R. Farmer, St. Louis, Mo., 552,057. Filed Jan. 25, 1895.
Relates to a means for introducing a current of electricity through a lamp, said lamp adapted to serve as a danger or other signal on electric car lines, and operated by the trolley-wheel of a passing car.

Conductors, Conduits and Insulators :—

Art of Making Armored or Compound Tubes, E. T. Greenfield, New York, 552,059. Filed May 16, 1895.
Armored Tube of Conduit, E. T. Greenfield, New York, 552,060. Filed May 16, 1895.
Above two patents describe method and apparatus for manufacturing insulated iron armored conduit. The inner treated paper tube is inserted in the exterior heated iron pipe with a cementing material between. The iron pipe on cooling contracts and grips the interior tube.

Distribution :—

System of Electrical Distribution, T. F. Mullaney, Worcester, Mass., 551,781. Filed Sept. 24, 1895.
When a ground is indicated, on the positive side, and there is already a ground on the negative side, the circuits can be so changed by means of switches that the grounds will both be on the same side of the system; and vice versa.
Converting Simple into Polyphase Alternating Currents, C. S. Bradley, Avon, N. Y., 551,809. Filed June 11, 1892.
Relates to the system described in the paper on "Phasing Transformers." See THE ELECTRICAL ENGINEER, Oct. 2, 1895.

Dynamos and Motors :—

Alternating Current Motor, C. S. Bradley, Avon, N. Y., 551,810. Filed Sept. 12, 1893.
Relates to a self starting alternating motor described by same inventor in THE ELECTRICAL ENGINEER Oct 2, 1895, page 324.
Commutator Brush, C. C. Dusenbury, Lake Mahopac, N. Y., 551,856. Filed June 10, 1895.
The arms are made integral with the end frame or permanently connected thereto.
Alternating Current Machine, M. Hutin & M. Leblanc, Paris, France, 551,-868. Filed May 1, 1895.
Improvement upon a like invention, patent No. 539,272. A synchronous alternating current motor of low resistance and self induction and having a constant field of force, and an asynchronous alternating current motor of comparatively high self induction, both simultaneously fed from the same alternating source and having their rotating elements mechanically coupled.

Lamps and Appurtenances:—

Electric Arc Lamp, E. Thomson and C. E. Harthan, Swampscott, Mass., 551,-799. Filed May 9, 1895.
Improvements relating to the manipulation of the carbons.
Material for Incandescent Conductors, L. K. Böhm, New York, 552,086. Filed Nov. 5, 1891.
Employs carbide of calcium.

Measurement :—

Station Potential Indicator, R. D. Mershon, Pittsburg, Pa., 551,982. Filed Apl. 29, 1895.
A station potential indicator for alternating current systems comprising a local circuit in which the inductive and non-inductive counter electromotive forces and the impressed electromotive force of the main line are reproduced in miniature, and a voltmeter for indicating the value of the resultant of these electromotive forces.

Miscellaneous :—

Electrogalvanic Belt, S. J. Spalding, Canton, O., 551,795. Filed May 9, 1895.
Electrical Eye Cup, T. B. Wilcox, Newark, N. J., 551,880. Filed Jan. 10, 1895.
A cup for application to the eye or other part of the body.
Art of Recording and Reproducing Impulses, W. H. Cooley, Brockport, N. Y., 551,946. Filed Apl. 16, 1889.
The object of the invention is recording of impulses capable of actuating a diaphragm and recording stylus, or equivalent device, in such a manner that such impulses may be reproduced from such record.
Automatic Temperature Regulating Apparatus, C. L. Fortier, Milwaukee, Wis., 551,951. Filed May 8, 1893.
Consists essentially of the combination, with means for operating a heat

controlling valve or damper including an electromagnet and electric generator connected by a circuit provided with a thermostat, of a motor arranged to operate said generator intermittently and automatically at stated intervals.
Thermostatic Regulating Device, C. A. Hale, Cleveland, O., 551,959. Filed Jan. 8, 1894.

Motor Regulation and Control;—

Electrically Operated Elevator, F. B. Corey, Boston, Mass., 551,757. Filed May 13, 1895.
The movement of the elevator may be controlled from several points either within or without the car, by means of simple switches or push buttons.
Mechanism for Operating Elevator Controlling Mechanism, F. E. Herdman, Winnetka, Ill., 551,820. Filed July 10, 1895.
Consists in operating the elevator controlling mechanism by means of an auxiliary motor.

Railways and Appliances:—

Electric Railway Train Signaling, W. S. Greene, Covington, Ky., 551,930. Filed Sept. 3, 1895.
Relates to a form of coupling for connection between cars.
Pedo-Electric Trolley, R. T. Oney, Charleston, W. Va., 551,996. Filed Mch. 27, 1895.
For description see page 16, this issue.
Underground Current Supply for Electric Railways, A. Rast, Nuremburg, Germany, 552,001. Filed Mch. 29, 1894.
Contact is made with the working conductors by electromagnetic switches enclosed in watertight boxes, and actuated by an attracting magnet carried on the car.

Switches, Cut-Outs, Lightning Arresters, etc.:—

Lightning Arrester, W. B. Potter, Schenectady, N. Y., 551,786. Filed Aug. 31, 1895.
Consists in an arrester provided with a plurality of spark-gaps arranged in series. Each of the spark-gaps is placed in an insulating-chute and separated from the others.

Telegraphs:—

Electric Telegraph, W. H. Cooley, Brockport, N. Y., 551,947. Filed March 23, 1889.
At any transmitting station, the operator, by pressing any one of a certain number of keys, can energize the corresponding electro-magnet at the receiving station. Each one of such electro-magnets at the receiving station can of course be used to actuate a different key of a typewriter or other similar instrument.
Electric Telegraph, W. H. Cooley, Brockport, N. Y., 551,948. Filed April 18, 1893.
Object of the invention is the lengthening of the time allowed at the receiving station for the printing of a character without diminishing the speed of transmission and receiving.

LEGAL NOTES.

THE RIGHT TO FIX TELEPHONE RATES.

S. STERNE VS. MET. TEL. & TEL. CO.

THE temporary injunction which Simon Sterne obtained a year ago preventing the New York Metropolitan Telephone and Telegraph Company from removing the telephone from his office at 56 Beaver street has been made permanent by Justice Ingraham of the Supreme Court, pending the action brought by Sterne for the same relief. He is required to give a bond to secure the company from loss of rents and damage, if it should ultimately be decided in the action that he was not entitled to the injunction.

The case is a test case, and turned mainly on the question whether the company has the right to fix rates arbitrarily, or whether it is a common carrier which must take business at such rates as the courts, in the absence of legislative direction, shall hold to be reasonable. Until October, 1894, Sterne had a telephone service at $125 a year, but in that month he and other subscribers were notified that owing to improvements in the service they must call and make new contracts for $240 a year. It was urged that the underground wiring had cost the company $3,000,000, and that it had resulted in better service. The company contended that its new rates were reasonable, and that in any event the courts could not say what it should charge its own customers, as it was a matter of private contract.

Mr. Sterne disregarded the threats of the company to remove his old telephone unless he signed a contract for the higher rates. He said that his old telephone was good enough for him. When the company finally set a day for him to sign or have the telephone removed, he procured the temporary injunction from Justice O'Brien. Owing to the importance of the case it was argued very fully last February, and Justice Ingraham had since then reserved decision, having to wait a large part of the time for briefs of the counsel.

Mr. Sterne submitted affidavits the aim of which was to show that excellent service was given in most of the large cities of Europe for from $100 to $125 a year, and that the defendant made large profits under the old rates.

An affidavit of President Charles P. Cutler stated that the service in London and Berlin was much inferior to that in this city.

Justice Ingraham said on the argument that he had no doubt that the Legislature had the right to supervise the rates charged, but the right of the Court in the matter was uncertain. In the decision handed down last week Justice Ingraham says:

"There can be no doubt whatever but that the Legislature could regulate the business of this defendant. I think it is clear that at common law, in the absence of legislative enactment, a common carrier is bound to furnish transportation to the public for a reasonable charge, and the courts, upon a proper application made, may determine in each case what is the proper and reasonable compensation to be paid to the corporation and compel the corporation to furnish transportation on the payment of such reasonable compensation. I am inclined to think that this duty of the courts extends to a business carried on under the authority of law which is in its nature a public business 'affected with a public interest,' and that the transmission of intelligence by electricity is a business of such a public character that it is to be exercised under public control.

"If this view of the law is correct, the question then arises as to whether or not the rate charged by the defendant for the services rendered is a reasonable charge under all the circumstances. I do not think that that question can be fairly determined upon affidavits. A much more satisfactory method of determining questions of this character is upon the trial of the issues where the witnesses can be cross-examined. The defendant should, however, be placed in such a position that if the plaintiff fails to establish upon the trial that he is entitled to a judgment he will pay upon such final determination the rate fixed by them."

DECISION IN CONNECTICUT ON ADJACENT LANDOWNERS RIGHTS.

In the Superior Court of Hartford County, Connecticut, Judge Ralph Wheeler has handed down a decision in which he says that a real estate owner claiming damages against a trolley company must prove unreasonable occupation of land by such corporation and must prove also for himself special and not general damages. Should this case be appealed it will raise in the Supreme Court of the state the whole question of the right of adjacent landowners to compensation from trolley companies.

The same question is to be raised soon in the Superior Court of New Haven in a case of the New Haven Steam Railroad Company against the Fairhaven and Westville Trolley Company, but Judge Wheeler's decision apparently anticipates it and is the first ruling on the subject in a lower court of the state.

SOCIETY AND CLUB NOTES.

HENRY ELECTRICAL CLUB.

AT the meeting of the Henry Electrical Club, on Dec. 20, Mr. Geo. F. Sever read a paper on "Testing of Dynamos and Motors."

He treated dynamo and motor testing as the determination of their electrical and commercial efficiency, and showed how the measure of the efficiency depended on the values of the various losses in the machines. These were divided as follows: Friction of bearings; brush friction; resistance of the air to the motion of the armature; Foucault currents; hysteresis in the armature iron; and the C^2R loss in armature and field coils.

In the case of the dynamo, the commercial efficiency was equal to the E. M. F. multiplied by the current delivered, divided by the total power supplied at the belt. In the motor it was the mechanical power delivered at the belt, divided by the product of the E. M. F. and the current supplied to the machine. The electrical efficiency was the counter E. M. F. divided by the impressed E. M. F.

With the aid of an extensive series of lantern views Mr. Sever described the steam-engine indicator; Emerson power scale; Weber power transmission dynamometer; Brackett cradle dynamometer, rope and Prony brakes, or absorption dynamometers; and electrical methods of the Hopkinson and allied types.

On Dec. 27 no regular paper was read. The evening was devoted to a general discussion of the subjects taken up in the course of the quarter.

REPORTS OF COMPANIES.

OKONITE CO.

The annual general meeting of the Okonite Company, Limited, was held at the office of the Company, 13 Park Row, New York City, on Wednesday, December 18, 1895. A number of matters of interest to the Company were discussed. The accounts were also presented and passed.

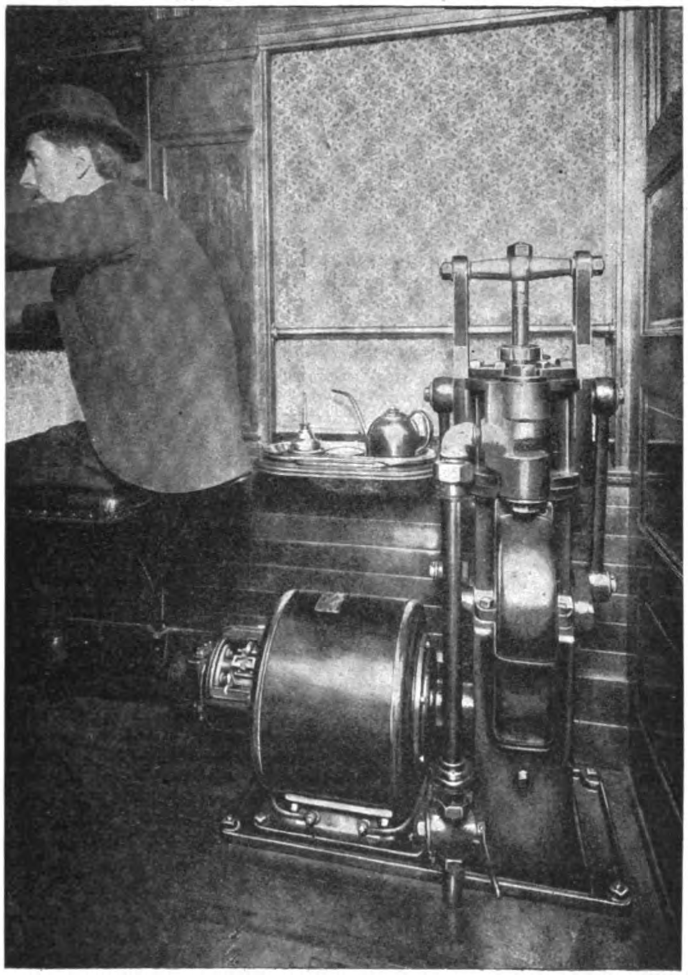
THE WESTINGHOUSE ELECTRIC & MFG. CO. have declared a quarterly dividend of 1¾ per cent. on the preferred stock, payable Jan. 2.

Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

STOREY MOTORS ON THE CHICAGO METROPOLITAN.

Without doubt one of the finest equipments of its kind that can be found is that of the Metropolitan West Side Elevated Railroad of Chicago, Ill. Elevated railroads in many respects far exceed all other means of transportation within city limits,—yet when operated by steam there are numerous features about them that are objectionable ;—thus the public are quick to appreciate a road which is operated by electricity. A very important feature in the smooth operation of a road lies in the system of braking. In this respect as in several others the equipment on the above system is second to none and this one feature presents several points of interest. The air-compressors, which were furnished by the New York Air-Brake Co., are placed in the cab set apart for the use of the motorman. These compressors are operated by motors directly connected and as will be seen by the accompanying illustration the equipment is very compact. The motors are



STOREY MOTOR ON THE CHICAGO METROPOLITAN ELEVATED.

completely enclosed, are dust and moisture proof, and were furnished by the Storey Motor and Tool Co. of Philadelphia, who also supply equipments of a similar kind for lighter work and for use on ordinary trolley cars as well as motors for all kinds of pneumatic equipments.

These machines run at a speed of 650 revolutions at 450 volts and develop 3½ H. P. They are constructed to stand an increase of voltage to 700 and occupy a space over all of 15⅛ by 30½". They weigh 400 pounds and there are at present 61 of them in operation.

It would be an agreeable surprise for some of our New York friends if they could take a ride on this road ;—they would surely be astonished to see the difference between an elevated road operated by electricity and one where steam is the motive power.

BARNEGAT LIGHTHOUSE, New Jersey, is to have one of the 3,500,000 C. P. search lights shown at the World's Fair.

THE "ENTERPRISE" LAMP GUARD.

THE incandescent lamp guard shown herewith, called the "Enterprise" and put on the market by Edward Darby & Sons, of the Pennsylvania Wire Works, Philadelphia, is, as will be seen, a very neat and handy contrivance. It needs no holder to fasten it to the socket, and constitutes an attachment easy to manipulate. Opening in the middle, it permits prompt and easy renewal of lamps. The wire is tinned, and the guard presents a light and graceful appearance.

GENERAL ELECTRIC BUSINESS.

THE Boston News Bureau says :—The General Electric Co. is doing a little better than $1,000,000 of gross business per month, and is striving for a fair manufacturing profit, but is not getting it on all lines. It is probable that the gross business for the fiscal year will foot up slightly above $13,000,000 which at prevailing prices means a very large tonnage of electric goods. There ought to be $2,500,000 manufacturing profit in this, but it is doubtful if such will be found when inventories are taken at the close of the year. However, it is expected that 8 per cent. will have been earned upon the common stock this year besides interest and full dividend on the preferred. Nothing, however, will be done this year toward the payment of any dividend on the preferred stock. They will be allowed to accumulate thereon for some time. It is felt that the matter can be better adjusted when the company has clearer views as to dividend policies than at present.

APPARATUS WANTED.

Mr. Ernest Gonzenbach, E. E., Supt., Electric Light & Power Co., Barton, Vt., writes us :

I have two or three contracts for isolated plants on hand and am in the market for direct current dynamos up to 60 kilowatt, also one new or second-hand 15-light arc machine and lamps. I would invite quotations with lowest net prices from your advertisers on the above apparatus, as well as on induction motors and wiring material.

BAXTER MOTOR CO.

The sale of the Baxter Electric Motor Company property to Benjamin Deford for $25,000 was finally ratified last week, by Judge Wickes in Circuit Court No. 2, Baltimore, the exceptions to the ratification being dismissed. Mr. Deford purchased the property in the interest of certain bondholders. It was claimed in the exceptions that the price was inadequate.

SIEMENS & HALSKE ELECTRIC CO.

The Siemens & Halske Electric Company of America have opened new offices in the American Surety Building, 100 Broadway, New York. This will be the General Eastern Office, and will be in charge of C. E. Yerkes, Vice-President.

F. N. Armour, recently of the Chicago Office, will be the General Sales Agent.

Chas. D. Shain still retains the Agency for New York City and the immediate vicinity.

THE WALKER CO. OF CLEVELAND.

The Walker Company, of Cleveland, has been incorporated under the laws of New Jersey, to manufacture electric generators and motors and other kinds of electrical apparatus. The capital stock is $2,500,000. John Ludwig, of Brooklyn ; Charles N. King and Martin W. Dixon, of Jersey City, are the incorporators.

DECORATIONS OF A PHILADELPHIA WEDDING FEAST.

MR. F. B. MASSEY, of Francis Bros. & Jellett, Incorp., did some elaborate special decorative work at the Mercantile Club, Philadelphia, recently for a wedding banquet. He used some 600 miniature lamps of various colors, and about 200 16-candle power colored lamps. The decoration comprised the placing of various colored lamps on the columns through the room, with banks of white lamps in side brackets along the sides. The tables were in the form of a hollow square, broken at either end ; with a massive heart-shaped table in the centre of the square. Decorations for the long tables were umbrella-shaped wire stands, having 18 miniature lamps each, and having in all some twenty stands. The lamps on each stand were different in color. The heart-shaped table was decorated with varied colors of stalactite lamps of

entirely new design. In the centre of the heart upon a raised platform, was a lion made from yellow chrysanthemums. The eyes of this animal were two red miniature lamps; around the lion was a massive bank of white chrysanthemums. Under the chrysanthemums were some 40 or 50 16-candle power lamps. The effect of these various colors showing through the flowers was very beautiful.

ADVERTISERS' HINTS.

A. O. SCHOONMAKER is again advertising his commutator segments.

THE "ENTERPRISE" LAMP GUARD requires no holder to fasten it to the socket. It is made of tinned wire by Edward Darby & Sons, Philadelphia.

GLASS AND PORCELAIN insulators, cleats, tubes, knobs, etc., are stocked in great variety and quantity by the Electric Appliance Co. who are quoting manufacturer's prices on all orders.

THE STANDARD AIR-BRAKE Co. claim to have been the first in the world to build air brakes for street railway service and to have received the only award for such brakes at the Columbian Exposition.

THE MICA INSULATOR Co. in their "ad" this week, publish some very interesting information regarding the electrical equipment of the "St. Louis" and the "St. Paul," the new steamers of the American Line. Micanite was the insulation used on all the dynamos and motors.

THE INDIA RUBBER AND GUTTA PERCHA INSULATING Co. begin the year by wishing all their friends a happy one and suggest that to use well insulated wires and cables means to avoid trouble and expense. They mention the Habirshaw products as meeting this requirement.

THE WESTERN ELECTRIC Co. call attention to a combination bridge, rheostat and galvanometer. This instrument consists of a sensitive detector galvanometer and an improved form of Wheatstone bridge, with rheostat, all arranged in one case so as to form a complete and perfect portable apparatus for measuring resistance.

NEW YORK NOTES.

THE J. E. PUTNAM Co. has been formed at Rochester, N. Y., to manufacture electrical appliances. The capital is $15,000. The directors are S. A. Ellis, J. E. Putnam and W. B. Hale.

A HUGE CHRISTMAS TREE, standing 40 feet high was one of the holiday sights in the store of Hilton & Hughes. There were 600 incandescent lamps on the tree and 400 in a bell and star above it.

MR. CHARLES COOPER, once so well known in electric lighting circles in Brooklyn, is returning to the field and is one of the prime movers in the new Kings County Electric Light Co., which is bidding at 32 cents a night for city arcs.

BROOKLYN EDISON.—The Edison Electric Illuminating Company of Brooklyn reports a net income for the month of November of $36,960, an increase of $6,831 over the corresponding period last year, and for eleven months of $314,878, an increase of $32,-999.

MR. L. J. HIRT, assistant chief engineer of the Metropolitan Traction Co., gave a lecture recently to about two hundred gripmen, on the mechanism employed on the road. President Vreeland introduced the speaker, and Supt. Newell of the Twenty-third street road presided. Mr. Hirt is not less well acquainted with the Metropolitan conduit trolley system than with the cable, and may presently give a talk on that.

MAGUIRE & BACKUS, LTD., of New York city, has been incorporated to purchase and sell or otherwise dispose of patents, licenses, contract rights, powers, privileges, etc., relating to inventions, machines and processes, electrical or otherwise. The capital is $250,000; and the Directors are Wm. H. Paxton, Jr., Walter B. Howe, M. C. Fleming, Dr. H. Clark and A. E. Miller, of New York.

MR. RALPH L. SHAINWALD, president of the Standard Paint Co., of New York, has just returned from an extensive trip in Europe, and says that he was much gratified to find that the famous P. & B. paint was just about as well known in Europe as in the United States. Even as far East as Egypt the magic initials are quite familiar, and the streets of Cairo are no strangers to the great and popular United States product.

THE NEW YORK CARBIDE AND ACETYLENE COMPANY has been formed to manufacture and sell gas-producing materials and acetylene gas and to distribute and deal in gas apparatus in Millbrook, Dutchess County; capital $7,000,000, divided into 70,000 shares, and the company begins business with its full capital; Directors—E. C. Benedict, Anthony N. Brady, Edwin N. Dickerson, J. Bertschmann, Charles F. Dietrich, Walton Ferguson, John Fox, R. Somers Hayes, Erasmus J. Jersnanowski, Frederick P. Olcott, Arthur B. Proal, John Sloane and Samuel Thorne of New York City. Julius J. Suckert of New York City subscribes for 69,988 shares of the capital stock of the company.

MR. W. R. BRIXEY, proprietor of Day's Kerite wires and cables, has very kindly complimented the editorial staff of THE ELECTRICAL ENGINEER with a Christmas present in the shape of a handsome Waterman stylographic pen. Such generous thoughtfulness is deeply appreciated, and it is hoped that many an occasion will present itself through the coming years to use the pen in extolling the virtues and victories of the donor's manufactures.

WESTERN NOTES.

GRANVILLE, O.—The Denison University have recently added to their electric light plant a 70 H. P. Ball engine, from the Ball Engine Co. of Erie, direct connected to a Thresher dynamo.

THE WESTINGHOUSE Co., through Mr. George Evans, has been looking for sites for a factory in the neighborhood of Toronto, Ont.

THE ELLIPTICAL CARBON Co. has been organized in Chicago by Fred DeLand, D. T. Foley and F. E. Drake with a capital stock of $100,000.

INSURANCE INSPECTION in Iowa of 890 risks showed 2,045 defects and 2,840 requests for improvements. Mr. W. C. Stewart, electrical inspector of the Iowa Alliance of Insurance Companies is making a complete canvass of the State.

MR. MARCELLUS HOPKINS, receiver of the Alley Elevated road in Chicago, says that the service costs $175 per day more with steam locomotives than it would with electric. "This is not a question of theory but has been fully demonstrated."

THE KANSAS CITY COMMERCIAL CLUB has approved a committee report strongly favoring underground wires, each company to lay its own conduits under exclusive control, but high voltage wires not to be buried.

"THE DANCING GIRL" of Chicago, graces with her beauty and agility the announcement of the Metropolitan Electric Co., who wish to intimate in this way the excellence of their goods and the celerity with which orders are executed.

THE AMERICAN ELEC. MFG. Co., St. Louis, have issued a 4-page circular as to the merits of their various incandescent lamps. Mr. A. L. Reinmann, formerly of the Sawyer-Man Co., is now their superintendent of factory, who is introducing many improvements he has effected in the last two years.

MR. THOS. I. STACEY, Secretary and Treasurer of the Electric Appliance Co., Chicago, has recently returned from a six weeks' visit to the South. Mr. Stacey was very pleased with his trip, and reports that the prospects for good times were very apparent in all the places he visited.

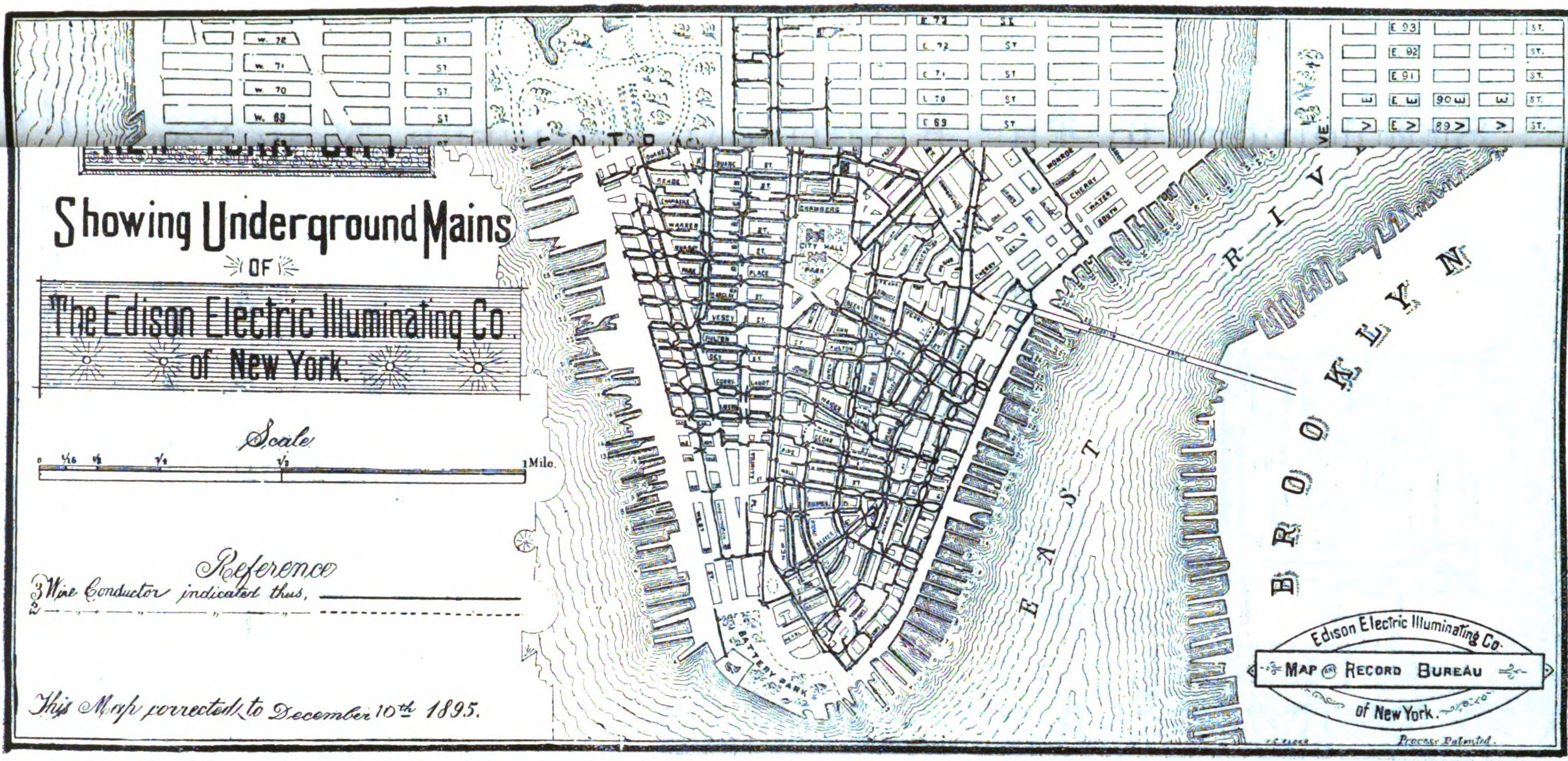
THE GATES ELECTRIC MANUFACTURING Co., of Chicago are making a specialty of direct connected dynamos in the smaller sizes particularly, the demand for which has not hitherto been supplied. They make dynamos from 5 K. W. and 400 revolutions upwards for connection to the engine without couplings or other space taking devices. The armature of large diameter is mounted directly on the engine shaft. The Gates dynamos are highly spoken of for their finish and smooth operation. They are now building a line of small multipolar motors and dynamos for belting.

THE SUNBEAM INCANDESCENT LAMP Co., Chicago, have recently commenced the manufacture of 2 C. P., 10 watt, and 4 C. P., 20 watt, incandescent lamps. These lamps have a small round bulb and are fitted with regular standard sockets. It is stated that the Sunbeam is the first lamp company to make lamps of such low candle power and wattage that can be connected in multiple. The principal use for these lamps will be in sign and decorative work. In sign work especially a lamp of low candle power is preferable, even without considering the saving in energy, as with the glow of the small incandescent lamp the sign is clearer than with the glare of the larger lamp.

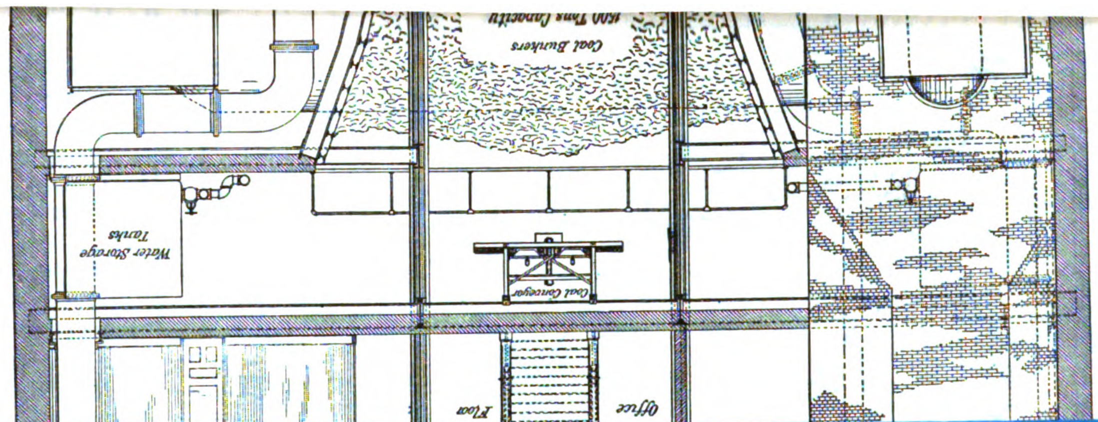
NEW ENGLAND NOTES.

MR. G. D. BURTON, inventor and electrician, has filed a petition in insolvency in Boston. He owes $115,000 but holds assets of enormous nominal value, though in many cases of highly problematical future.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Financial, Miscellaneous, etc., will be found in the advertising pages.***

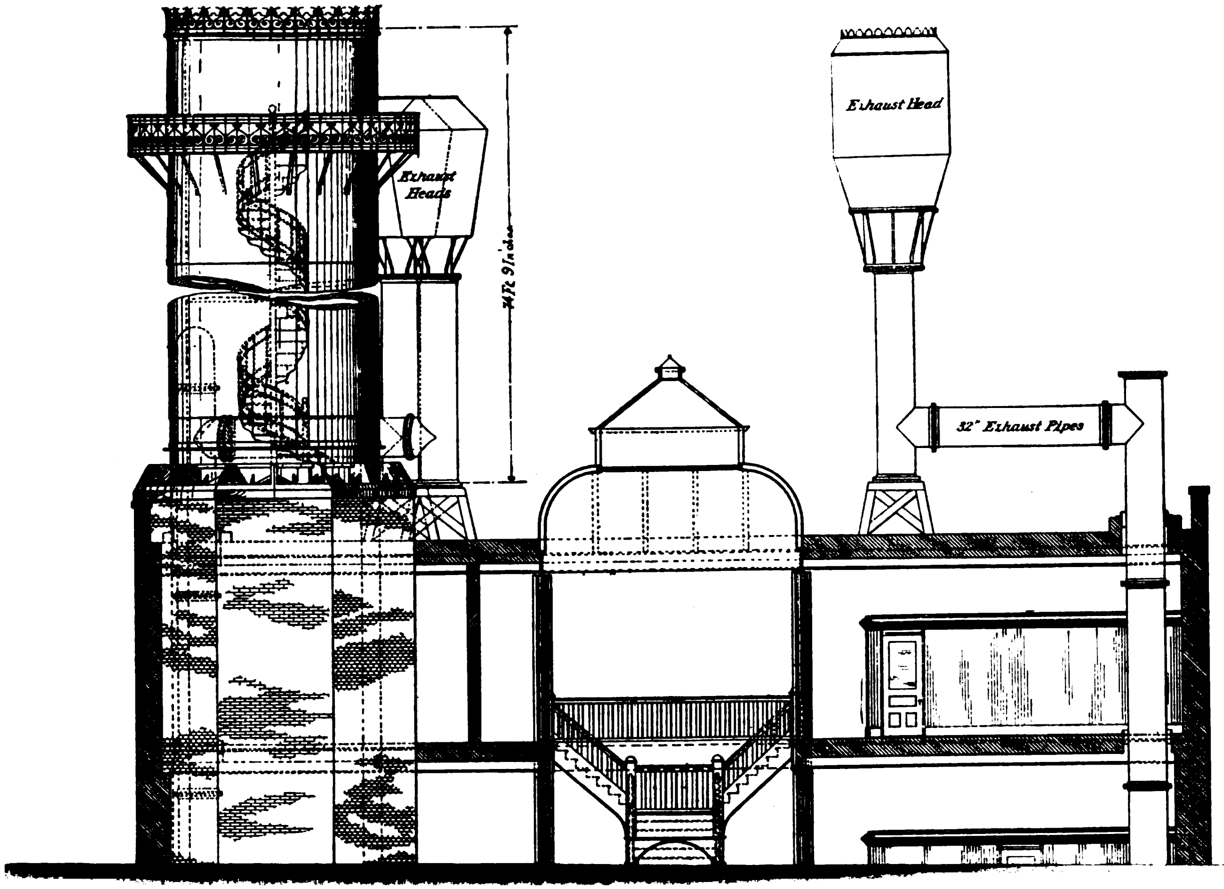


Showing Underground Mains
OF
The Edison Electric Illuminating Co.
of New York.
Scale
1 Mile.
Reference
3 Wire Conductor indicated thus,
2 " " "
This Map corrected to December 10th 1895.
EAST RIVER
BROOKLYN
BATTERY PARK
CITY HALL PARK
Edison Electric Illuminating Co.
MAP AND RECORD BUREAU
of New York.
Process Patented.



Coal Bunkers
Water Storage Tanks
Coal Conveyor
Office
Floor

Supplement to The Electrical Engineer, New York.
Vol. XXI. No. 401. January 8, 1896.



The

Edison Electric Illuminating

Company of New York.

THE
Electrical Engineer.

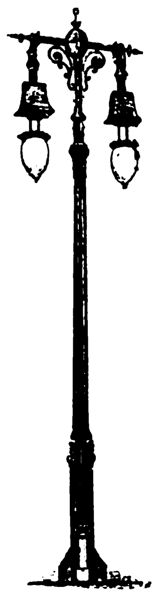
Vol. XXI. JANUARY 8, 1896. No. 401.

THE EDISON ELECTRIC ILLUMINATING CO. OF NEW YORK.

BY

Jos. Wetzler.

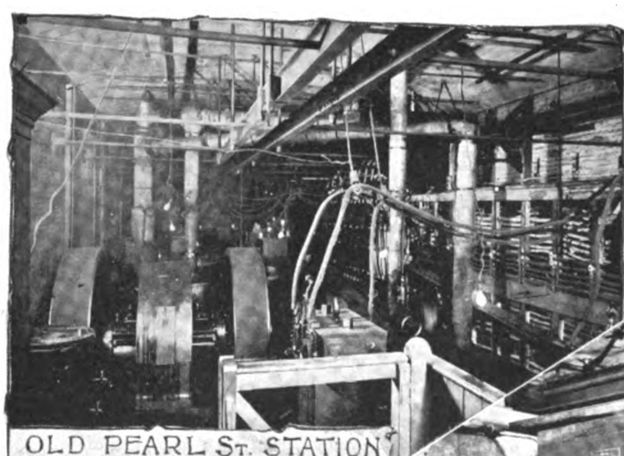
HISTORICAL.



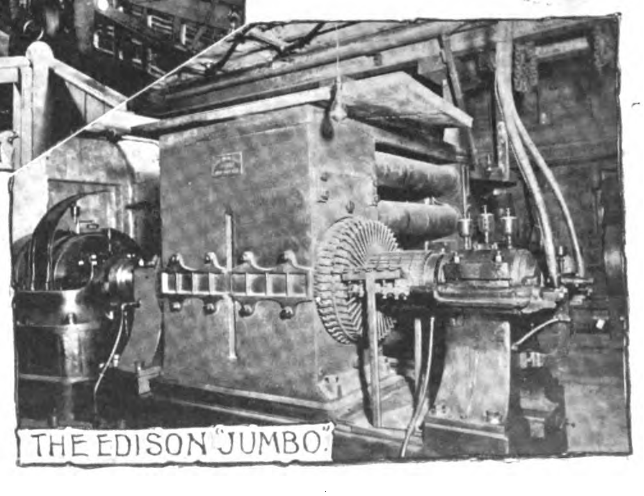
5th Ave Arc Lamp Post, Edison-Bowker System.

THE history and growth of an organization which stands as the pioneer of one of the greatest of modern industries, has not merely a value viewed from the academic standpoint, but carries with it lessons of practical import; and the more so when that history is one of continuous progress both technically and commercially. Perhaps no more conspicuous example of this kind could be found than that exhibited in the record of The Edison Electric Illuminating Co., of New York, which from its inception has been in the vanguard of progress in everything relating to low-tension generating apparatus and underground electric distribution; which has, at no small cost necessarily done much of the experimental work which has accrued to the benefit of all electric companies, and which remains the largest electric light and power supply corporation in the world.

Mr. Edison had barely finished his historical experiments when enterprising capitalists decided to introduce the new light in New York City. They proceeded at once to carry out their designs by the purchase in May, 1881, of two buildings on Pearl St., near Fulton, and shortly after began the laying of underground tubing and the wiring of houses. The conductors consisted of the familiar, but now obsolete "half-moon," type, made to conform to the outline of the iron tubing, and its installation occupied the personal attention of Mr. Edison, who for months frequently worked in the trenches and whose bed often consisted of a pile of tubing with a few overcoats thrown over it in the old construction office in Ann St. At the same time the construction of the—for those days—mammoth Edison "Jumbos" was proceeding apace, so that on July 5, 1882, the dynamos were run for testing purposes, and on Sept. 4, 1882, the Pearl St. station was regularly started with six Jumbo Edison steam dynamos of 125 H. P. each, direct coupled to Porter-Allen engines, lighting during the first month 85 houses, wired for 2,323 lamps.



OLD PEARL ST. STATION



THE EDISON "JUMBO."

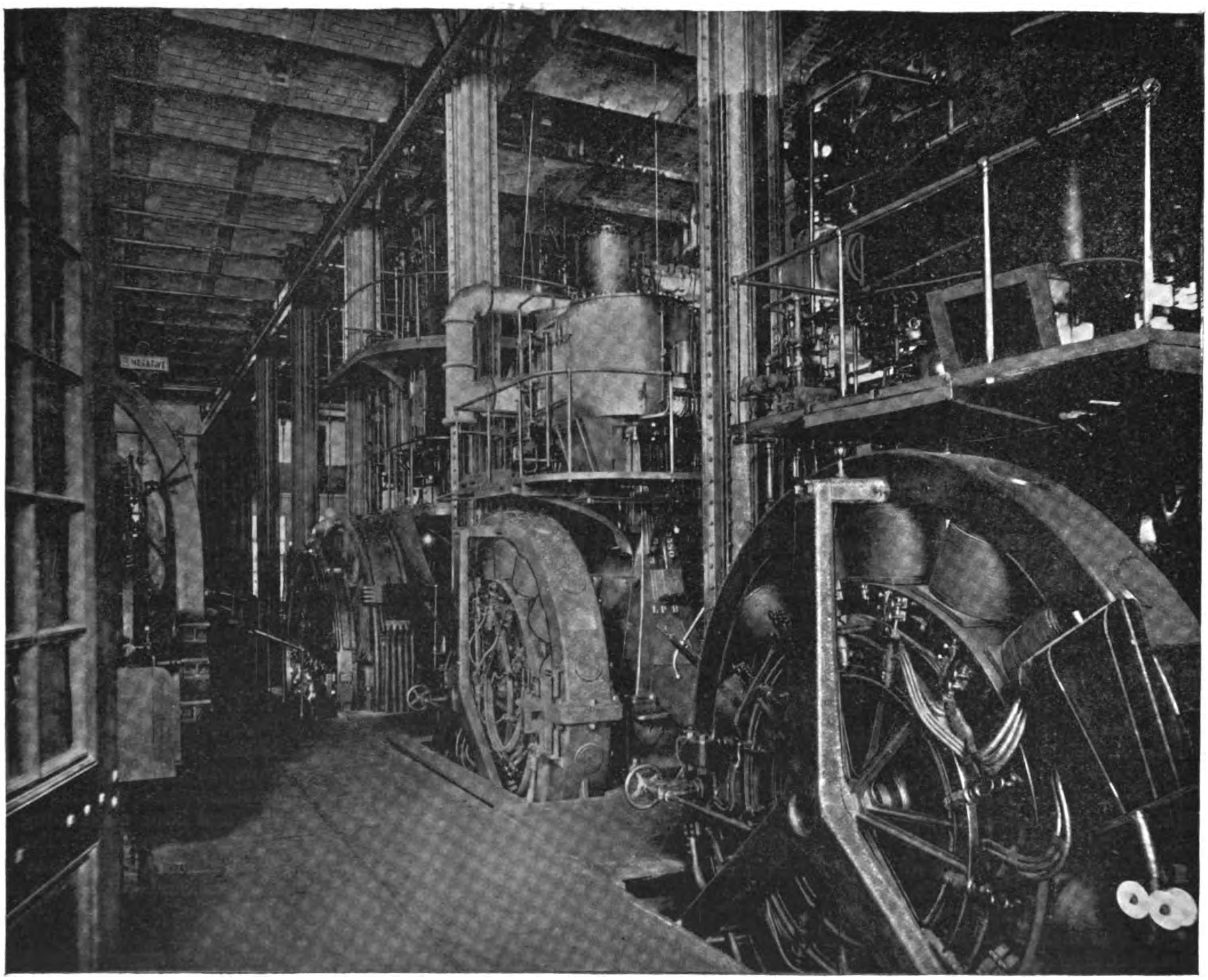
Among those who were with Mr. Edison in this epochal work were John Kruesi, afterward Manager of the Schenectady Works of the General Electric Co., who was developing the underground system; Sigmund Bergmann, who manufactured the electrical supplies; Charles L. Clarke, the well-known electrical patent expert; Julius Hornig, mechanical engineer; H. M. Byllesby, afterward General Manager of the Westinghouse Company; John W. Lieb, Jr., for many years Technical Director of the Italian Edison Company and now returned to the New York Company as its Assistant General Manager; H. C. Patterson, afterward Chief Engineer of the Thomson-Houston Company; Charles S. Bradley, now of the Fort Wayne Electric Corporation; Dr. S. S. Wheeler, afterward Electrical Expert of the Board of Electrical Control and now President of the Crocker-Wheeler Electric Motor Company; E. T. Greenfield; Harrison J. Smith, now General Operating Superintendent, and H. A. Campbell, now Uptown District Superintendent of the New York Company; and others, all men whose names have become well-known in the profession. In fact "Old Pearl Street" was an electrical university in its day, whence Mr. Edison's pupils literally went out into all lands.

The first president of the N. Y. Edison Co., was the late Dr. Norvin Green, Major S. B. Eaton, still of counsel for the Company, being the vice-president and working executive and later succeeding Dr. Green as President. The first superintendent was Mr. Joseph Casho, and his suc-

cessor was Mr. C. E. Chinnock. The original underground two-wire system connected to the Pearl St. Station included 4 miles of feeders and 9½ miles of mains, covering about a square mile of territory, extending from Wall St. to Spruce and Ferry streets, and from Nassau St. to the East River, the farthest point of extension being about 3,000 feet from the station.

Five years' practical operation of the Company had sufficed to demonstrate the success of the undertaking and to justify its extension to the uptown districts. Mr. E. H. Johnson had been a leading spirit from the start and his strong belief in the future of the Company enlisted the support for its further plans of development General Manager during the earlier development and until August, 1890. Mr. R. R. Bowker, then new to the electrical profession, became First Vice-President in February, 1890, and the later development of the Company has been under his direct administration as the active Executive.

There were not wanting the croakers to predict failure of the service when the current was first switched into the mains, but it stands to the credit of the Company that from the very first day of its operation the current has been uninterrupted save for a space of about three hours at the time that the historical old Pearl Street station was visited by fire. The appearance of this station as it was reconstructed after that unfortunate occurrence will be



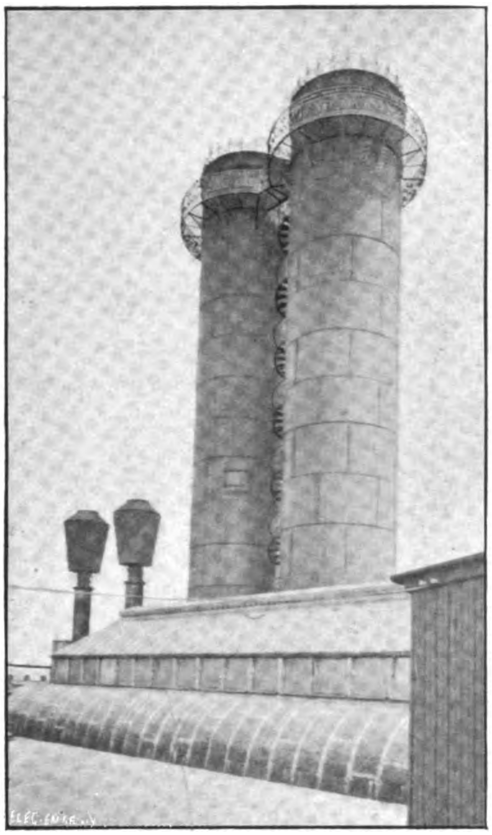
OPERATING ROOM, DUANE ST. STATION, EDISON ELECTRIC ILLUMINATING CO., NEW YORK.

of Mr. J. Pierpont Morgan, whose firm, still represented in the Board by Mr. C. H. Coster, has been one of the guiding factors in its success; and with Mr. Spencer Trask, of the banking firm bearing his name, as President, the 26th and 39th Street stations were built, starting into operation late in 1888, and the beginning of an underground system was made uptown. Mr. Trask has continued in the Presidency till this time except during an absence in Europe, when that post was occupied by his partner, Mr. Geo. Foster Peabody. Mr. F. S. Smithers, another well-known banker, still in the Board, was for some time First Vice-President. Mr. John I. Beggs, now of the Cincinnati Edison Company, was Vice-President and gathered from a glance at the engravings on page 25, which also show one of the Edison Jumbos.

FINANCIAL AND STATISTICAL.

The growth of this Company, especially of late years, has been a striking illustration of the rapidity and extent of electrical development. Its service was at first exclusively for incandescent lighting; motor supply was begun in 1884, and arc lighting in 1889. At the beginning of 1890, the Company counted 1213 customers, 39,815 incandescent lamps, 77 arc lights and 470 horse power in motors on its system. At the end of 1895, it counted 6,675 customers, 271,123 incandescent lamps, 3,424 arc lights, 12,046

Facade of The Duane Street Station, Edison Electric Illuminating Co., New York.



THE "HEAVENLY TWINS."

horse power in motors, or at the rating now adopted by the large Edison companies of 10 16 C. P. incandescent lamps to the standard arc light and 15 to the horse power in motors, an equivalent of 486,060 16 C. P. incandescent lamps.

Current is supplied from six stations, the great Duane St. central station (started 1891), and its annex in the Produce Exchange (1890); the 12th St. station (1894–5); the 26th St. central station (1888); the 39th St. station (1888); and the 53rd St. station (1892). These stations feed current into 203 miles of underground tubing, requiring 608 miles of conductors for feeders and mains.

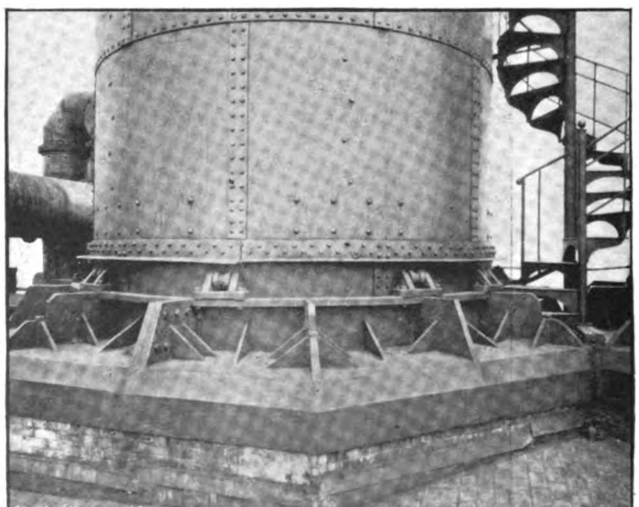
The capital stock of the Company is approximately $8,000,000 and the bond issues $6,500,000, making an investment of $14,500,000, less $500,000 in bank yet to be expended. The gross income in 1895 was over $1,560,000 and the net income approximately $800,000, yielding 2 per cent. above the 6 per cent. dividend. This investment includes, however, the purchase of all the securities (except $64,000 bonds) of the Manhattan, Harlem and Madison Square Companies, now virtually consolidated as a high tension division of the Edison Company. Their 27,800 incandescent and 2060 arc lights bring the Edison totals to an equivalent of 534,460 16 C. P. lamps, and their earnings bring the aggregate income to approximately $2,000,000 gross and $930,000 net. The Edison system proper now extends from the Battery to 79th St., a distance of 5½ miles; with these high tension additions, all now underground, to 125th St., nearly 8 miles. And all this is the development of but 15 years!

DUANE STREET STATION.

As originally planned by Mr. Edison, New York below the Central Park was divided into thirty-eight lighting districts, the old Pearl street station being in the centre of the first district and that part of the City south of Wall street constituting the second district. His "three-wire" development made low-tension distribution practicable commercially more than a mile away and as the richest lighting territory, along the backbone of the island, has been specially cultivated by the Edison Company, it has come about that the successive stations have been built in almost a direct line, nearly north and south. When the permanent central station to replace "Old Pearl street" was to be located, a site was found at Duane, Elm and Pearl streets which was half a mile from either river, one mile from the Battery, and from which could be supplied the whole lower part of the City as far north as Eighth street, a mile and a quarter away, or even 14th street, a mile and a half away. The central location of this site more than compensated, by its economy of copper and prevention of loss in feeders, for the advantage of being at the water side where water could be had for condensing purposes and coal could be delivered directly. Moreover, it was found that the site was above a water-bearing stratum about sixty feet below the street level, which might possibly be utilized for condensing purposes if an artificial water-cooling system were not developed. A plot 100 x 200 feet was therefore purchased from the A. T. Stewart Estate in July, 1890, at a cost of about $280,000.

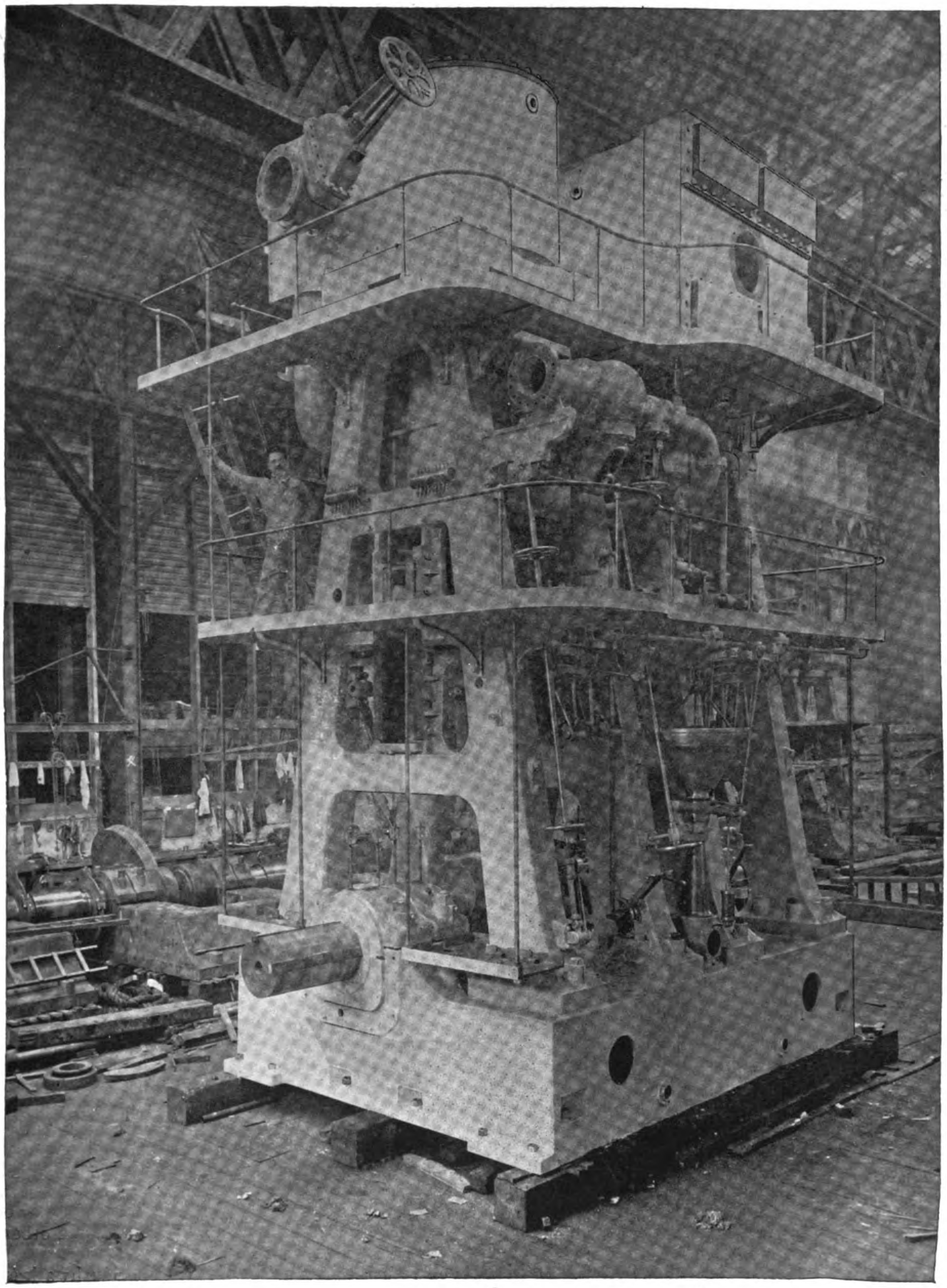
As it was at that time planned to extend Elm street along its present line, space was allowed for that purpose to the west, and the station was confined to a plot 74 feet on Pearl and Duane streets and 200 feet between streets. The change in the plans of the Elm street extension brings the new street to the east of the station and leaves its north façade or station-entrance fronting on an open space. Ground was broken in August, 1890, and by May 1, 1891, when the annex in a basement on Liberty street, with which the old Pearl street station had been supplemented, was given up, its machinery had been moved to the concrete floor on the new site, so that the station was put into commission on that day. The building was, in fact, erected on the old Scotch plan of "building the new church while the old was in use and using for it the materials of the old." As soon as the building reached the second story, all the administrative offices of the Company, which had hitherto had headquarters at 432 Fifth Avenue, fiscal offices at 16 Broad street and other administrative divisions elsewhere, were concentrated in General Offices in the Pearl street end, where they remained until the building was sufficiently completed, in April, 1894, to permit of their removal to the permanent place on the 7th and 8th floors of the new building, which is now at once the largest lighting station of the Company—and the permanent headquarters of all its departments.

The front of this magnificent edifice, designed by the company's architects, Buchman & Deisler, is shown on page 27. The first three floors are built of granite and above this buff colored brick has been employed, giving to the



FOUNDATION OF SMOKE STACKS SHOWING ROLLER BEARINGS.

whole a light and graceful appearance. The edifice is planned from within outward, as all good architectural work should be, and the characteristic features of its which was to be confined within the proper limits of an industrial building, the characteristic industrial application of the structure should be symbolized.



2,500 H. P. SOUTHWARK QUADRUPLE EXPANSION ENGINE IN DUANE STREET STATION. (VIEW TAKEN IN ERECTING SHOP.)

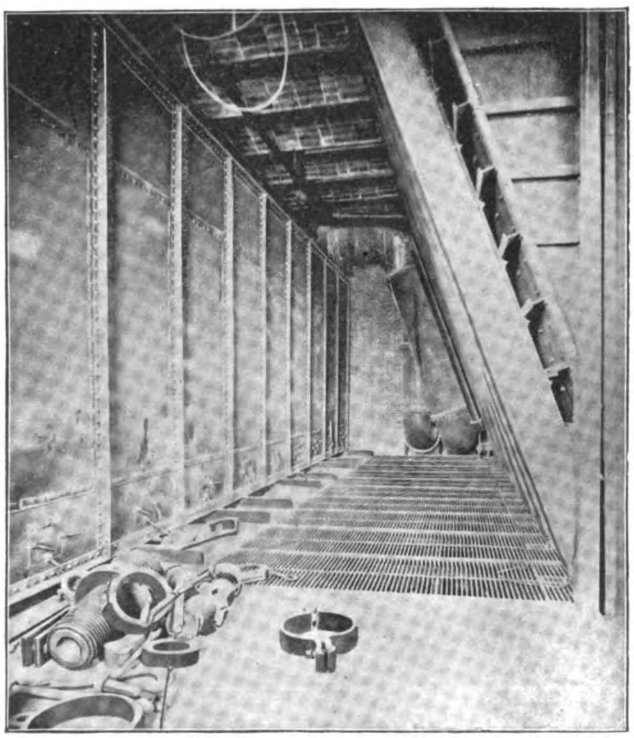
façades indicate the use of the story within, the flat space with a central doorway and balcony representing, for instance, the boiler floor. The directions to the architect were that throughout the ornamentation.

Accordingly, above the broad station entrance, bearing the name of the Company, on the Pearl Street or north side, are four decorated panels which will eventually bear the profile or names of the four celebrities,

Volta, Ohm, Ampère and Watt; the four corresponding panels on the Duane Street side will bear the names of four American electrical worthies. The panels between the hinged windows on the floor immediately below the balcony, as well as in the panels under the eaves of the roof, bear symbolical representations of the multipolar dynamo, while the incandescent lamp has been appropriately embodied in the designs for the string courses and like ornamentation.

THE POWER EQUIPMENT.

As it first presented itself it appeared possible to put down only fourteen 600 H. P. engines, giving a total of 8,400 H. P. The low ratio of power to area at once became apparent and an effort was made to increase the power capacity by the construction of an engine more economical of space. This was done and 1,250 H. P. engines were then considered, raising the station capacity to 17,500 horse power. Nevertheless it was considered desirable to have a number of small units, and two 600 H. P. engines were installed, and a third 600 H. P. engine together with two 1,250 H. P. engines were added. Further study of the problem made it apparent, however, that the available area could be still further economized by the employment of two-crank four-cylinder engines and that by the installation of this type the power could be still further augmented by the placing of nine 2,500 H. P. engines in addition to the smaller ones above cited. This arrangement, as now adopted, is shown in the engraving on the accompanying insert, which shows a plan view of the operating room of the station, the present engines installed being shown in full lines and those contemplated for future installation being shown in dotted lines. When all these engines shall be in place the station will have a total capacity of 26,800 H. P., or, if the third 600 H. P. engine is replaced by one of 2,500 H. P., 28,700 H. P., that is, a horse power for each half square foot of real estate. This is a most remarkable achievement and one which is probably not exceeded in economy of space anywhere in the world.



View of Smoke Flue Under The Coal Bunkers.

A very clear idea of the manner in which it was possible to concentrate steam and electrical apparatus of such capacity on such a small superficial area will be gathered from an inspection of the cross-section of the station illustrated on the inserted supplement sheet. In its main lines the station follows the construction adopted in the older 26th and 39th Street stations erected in 1887-88, and illustrated on later pages. In these instances the placing of the boilers above the engines doubled the power area of the station with a slight additional expense. The principal variation in the design of the Duane Street station consists in concentrating the engines and dynamos on one floor, made possible by the adoption of direct-coupled multipolar generators; in the location of the smoke flue above the boilers instead of below them, this space in the Duane Street station being occupied by steam piping; and in the insertion of two separate floors between the boiler and engine rooms, one floor for heaters, separators, store room, machine shops, etc., while the floor directly under the boilers is occupied by pumps, blow-off tanks, water pipes, ash tramways, etc. It was also decided to make this station the headquarters for the administrative and technical staff of the Company, and with that end in view two floors were added above the coal bunker stories.

With this general description of the station and the causes which led to its present construction, we now propose to enter into the details of the methods of construction and of the apparatus adopted.

THE ENGINES.

The economy in space which has been effected by the practice adopted by the New York Edison Company is due to the adoption of a type of engine design due to Mr. J. Van Vleck, the Company's chief electrician and constructing engineer. This design consists essentially in placing the steam chests in front of and not between the cylinders, and in using radial valve gear, which permit the engines to occupy two-thirds the length which they otherwise would. A distinctive feature of the 2,500 H. P. engines employed is, that they are built on the two-crank four-cylinder type principle which made it practicable to employ quadruple expansion instead of triple expansion. In this connection it might be interesting to note that the New York Edison Company was the pioneer in the introduction of vertical engines of the marine type for driving electric generators, being, as a matter of fact, the first in this country to build an engine of this type of the present sizes.

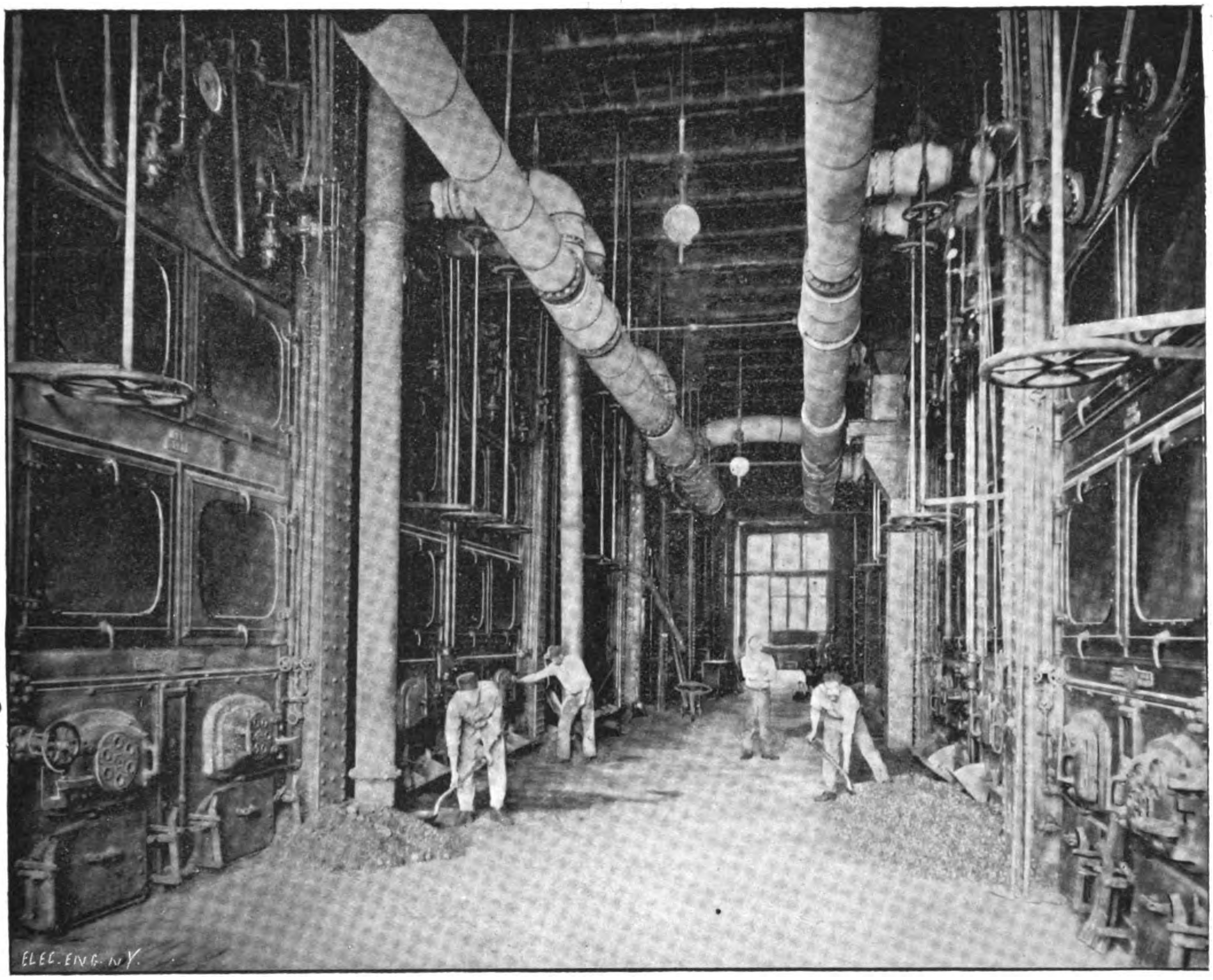
The operating room, a perspective view of which is given on page 26, occupies the full width of the station, the engines, all direct-connected to General Electric dynamos, two to each engine, being arranged in two rows with an aisle through the centre. This room is 29 feet high, 65 feet wide between walls and 160 feet long. At the present time the station contains one quadruple expansion engine of 2,500 H. P., two engines of 1,250 H. P., and three engines of 600 H. P., all built by the Dickson Mfg. Co., of Scranton, Pa.; and a second 2,500 H. P. quadruple expansion engine, built by the Southwark Foundry & Machine Co., of Philadelphia, which has just been put in commission. In addition to the engines above mentioned there has been temporarily placed a McIntosh & Seymour horizontal engine of 250 H. P. The details of the sizes of these various engines are given in a table elsewhere, which also gives the number and power of the engines, boilers and dynamos located in the other stations of the company.

A view is given of the magnificent Southwark engine, on page 29, as it appeared in the erecting shops before shipment. On this engine two 800 K. W. generators are carried directly on the ends of the crank shaft, and run at 90 revolutions per minute. At this speed, and with 200 pounds initial steam pressure, the engine will develop, with maximum economy, 2250 indicated horse power; and a maximum power of 2,800 H. P.

The steam cylinders were so proportioned as to make

the engine most economical both with or without condenser, and are 29", 38", 54", and 72" x 39" stroke. The high and second intermediate pressure cylinders are placed tandem, and work on one crank, while the first intermediate and low pressure cylinders are tandem and work on a second crank, set 90 degrees from the first.

The larger cylinders are placed above and are bolted to the tops of the housings, of which there are four, all of the regular cast iron "A" box type. The lower cylinders are bolted to the upper cylinders in such a way that the bottom head of the upper cylinder forms the top head of the lower cylinder. The top heads of the top cylinders and the bottom heads of the bottom cylinders may be removed to permit examination of the piston packing, the pistons being so constructed as to allow the packing to be replaced from the open ends of the cylinders. All the cylinders are steam jacketed. The high and low pressure cylinders are each fitted with four independent valves of the Porter-Allen type, while the two intermediate cylinders each have a single, double-ported, flat, balanced valve. A radial valve gear is used, the motion being taken from a point on the connecting rods, the steam and exhaust valves receiving motion independently of each other. The cut-off on the high pressure side is controlled by a Porter governor, while, in the other cylinders, it may be adjusted by hand while the engine is running. By a system of disconnective piping, either side of the engine may be run alone in the event of accident, and provision is made to connect the governor to the valve gear on the low pressure side, should the high pressure side be disabled.



View in Boiler Room, Duane Street Station, Edison Electric Illuminating Co., New York.

THE MULTIPOLAR GENERATORS.

A prominent feature of the Duane St. station is the large multipolar generators direct coupled to the vertical compound engines. Though now a familiar sight in central stations, the adoption of this type of machine in the United States is due to the initiative of the New York Edison Co. As a result of their independent investigations, they became convinced that the belt driven dynamo ought to find no place in their new stations and as a result placed an initial order with the General Electric Co., for two 200 K. W. machines; this was followed by the construction of 400 K. W., and led finally to the 800 K. W. machines now used as the standard in connection with the 2,500 H. P. quadruple expansion engines. These dynamos are the largest of their kind employed in this country for electric lighting. The field rings of these machines are of cast steel and it is interesting to note that the present 800 K. W. machines are no larger than the first 400 K. W. machines which had cast iron field rings. The armatures of all these machines have the Gramme ring winding and no separate commutator is employed, the brushes bearing directly on the periphery of the winding which is bared for that purpose. It is worthy of note that the wear on the surface under the brushes is almost inappreciable and

that the design of the machines is such that no sparking or excessive heating occurs even on heavy overload.

THE ELECTRICAL CONTROLLING PLATFORM.

Perhaps the most original and distinctive feature of the operating room is the controlling platform, raised about four feet from the floor, and situated, as shown by the plan on the insert, in the central part of the room, which provides for controlling apparatus to handle 28 dynamos and 132 thousand-ampere feeders within a length of 20 feet. To accomplish this Mr. Van Vleck devised his "Edgewise System," by which, instead of moving field-regulating switches and meter index-hands around the flat face of a circle, these are handled or read on the edge of the quarter-circle.

At the front of the platform, as shown in the left-hand cut on page 33, are the dynamo-controlling devices, so compact that each 800 K. W. dynamo is handled within a six-inch space. Nearest the floor are the controlling switches, by raising the handles of which, each dynamo is thrown on the system. Next above are the regulating quadrants; by raising their handles the field resistances are successively cut out and the power and output of the dynamos increased. Above this is the voltmeter, its index rising as the pressure rises, and above all is the ammeter, its index rising as the quantity of current is increased. Every motion "throwing on," or showing increase of energy, is upward; every motion "throwing off," or showing decrease, is downward; and the attendant has only to glance upward from his switch-handles to see the effect of each act indicated directly above.

At the back of the platform, as shown in the right-hand engraving on page 33, are the feeder-controlling devices, so compact that each thousand-ampere feeder is handled within a three-inch space. Nearest the floor are the connecting switches; by raising their handles each feeder is thrown on the system. Next above are the safety-catches, preventing an excessive rush of current over any one feeder; above these a neat label indicates the location of the feeder-end in the street. Above this again is the ammeter, whose index rises as the feeder carries out more and more current. Above all is the voltmeter showing the pressure at the feeder-end as indicated through the pressure-wires. These instruments are all of Weston make.

The up-and-down feature has an incidental usefulness in the fact that on the row of voltmeters, the pointers, when the voltage of the system is uniform, are in a straight horizontal line, while any variation from standard is emphasized by a deviation from this line.

All apparatus for the positive side of dynamos or feeders is painted red; for the negative, blue, a picturesque as well as practical feature, especially as all positive feeder-connections are grouped at the right and negative at the left end of the feeder switch-board.

Below each vertical rheostat quadrant is a small galvanometer switch which connects the dynamo with a potential indicator. When the proper potential is indicated, the main dynamo switch is thrown up from below and automatically opens the circuit to the instrument.

Situated between each of the main dynamo switches is a single bar knife switch which controls the field-exciting circuit in a manner intended to obviate the difficulties and dangers due to the sudden rupture of a field circuit, on an ingenious method devised by Mr. W. I. Donshea of the Company's staff.

For the charging of the fields, a separate bus is employed so that in case the necessity should arise, the dynamos can be charged from an independent dynamo not connected to the distributing system.

In the arrangement of the station circuits the two outside poles of the dynamos go to a set of positive and negative dynamo switches placed on a switchboard at the back of the feeder switches, as shown in the plan view on the insert.

The current is led to this board from the dynamo terminals by lead-covered stranded cables, which pass under the floor and are brought up to a lug at the back of each switch. The circuit then passes down through the front of the switch, which is mounted on slate blocks six inches thick. After passing through the switch blade it reaches a terminal on the lower part of the board, then passes through laminated strips of copper five inches wide leading to the bus bars to which the laminated strips are clamped. The bus bars consist of two rolled copper bars, one inch thick and fourteen inches wide. If the carrying capacity of the bar, owing to increase of output, becomes too low it can readily be increased by sliding in an additional copper strip without disturbing any connection.

Mounted above, but insulated from the main busses, are the low auxiliary and the high auxiliary busses, to which the short and long feeders respectively can be connected.

The feeder switches, one section of which is shown on page 33, are built up in sections intended eventually to control sixty-six feeders on both the positive and negative sides. At present, forty switches with their corresponding edgewise ammeters above them are in position and occupy a space no greater than ten feet. Each feeder has two switches so as to connect to either the main or auxiliary busses.

LOAD AND PRESSURE RECORDS.

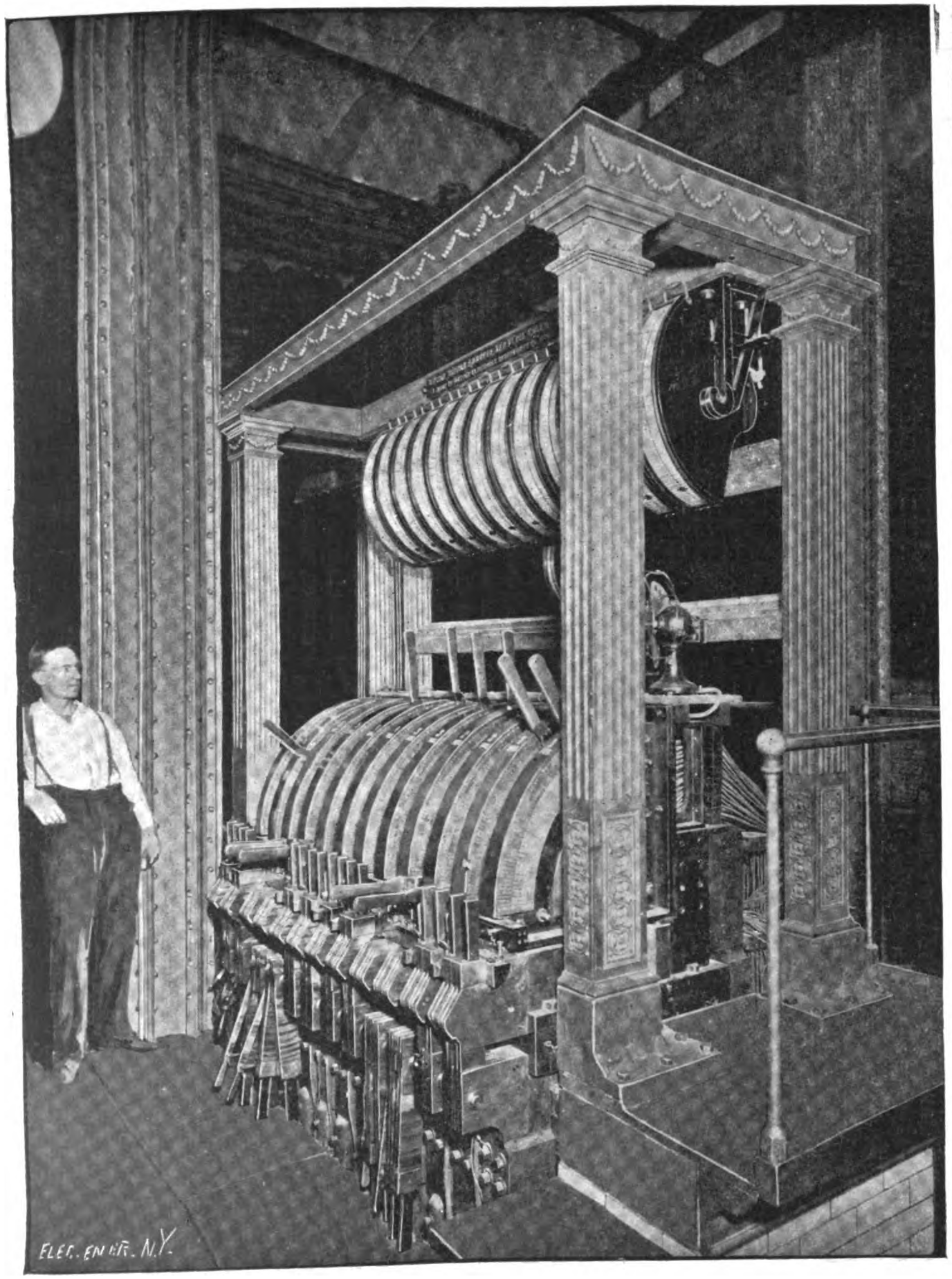
At a convenient point in the electrical regulating gallery a desk is located to which the pressure wires from the feeders are brought, and tests are taken at regular intervals so as to determine the distribution of the pressure on the various parts of the system, while the most important feeders are permanently connected to the main regulating indicators. In addition to this, Bristol recording voltmeters record the pressure on the standard feeder which goes to the most important centre of the district. A load record is taken every fifteen minutes and plotted on tracing section paper. On this chart is also noted the time that each engine is started. From these charts blue prints are made which go to the heads of departments for their inspection.

At regular intervals the indications on the various charts are summated and that shown on page 34, gives the record for the entire system on Dec. 13th last. From this it will be seen that the maximum load on the whole system was attained between 5 and 6 P. M., and reached the enormous total of 63,140 amperes,—a truly remarkable result. This chart also shows the individual record of the uptown and the downtown districts. This record, representing, as it does, the work of the largest electric lighting system in the world, presents a number of interesting features. On Dec. 23, the maximum load reached 66,800 amperes.

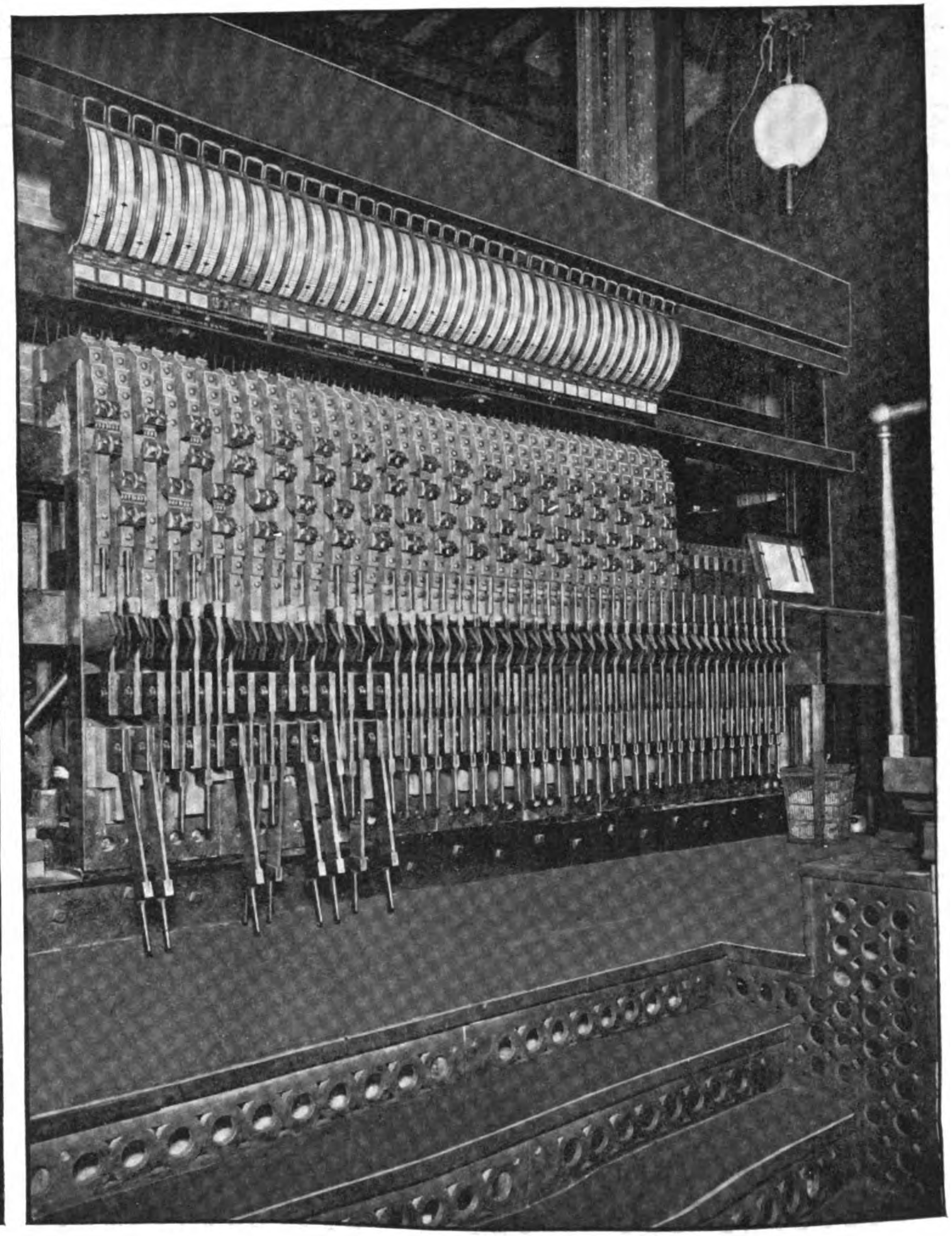
HEATERS, SEPARATORS AND PIPING.

Immediately above the engine room and on each side, are constructed the heater and pipe rooms in which a large portion of the station steam piping equipment is placed. This piping connects directly from the engine room through the open-work ceiling. Through the openings thus made, the hot air from the engine room finds its way into the heater room and finally passes through the blower into the boilers. Thus ventilation of the engine room is assisted and the hot air at the same time economically employed.

The steam pressure carried in the station is 200 pounds to the square inch. The piping, from boilers placed on the fourth floor to the engine below, at such great pressure and for such large powers, presented a most serious problem, and therefore had great care bestowed upon it. The present arrangement embraces two main lines of pipe in the boiler room on each side of the central aisle which is clearly shown in the sectional view and in the perspective of the boiler room shown on page 31. These pipes range from ten to eighteen inches in diameter. From each one of these mains eight 14-inch pipes run down to main lines in the engine room. Into each downtake there are inserted two 14-inch water separators; one of the Company's own design and one of the Stratton



The Dynamo Controlling Section.



The Feeder Controlling Section.

The Van Vleck "Edgewise" System of Electrical Controlling Apparatus, Duane Street Station.

type, making sixteen separators in all. The down-take from each separator leads directly into a 14-inch steam trunk main placed on each side of the engine room, supported directly by the wall. From the top of these mains, steam lines are carried to the engine throttles with the additional insertion of a Stratton separator in some cases and a Climax separator in others.

In order to allow for expansion and contraction in the steam piping, it has been necessary to employ a large amount of copper pipe. This pipe is peculiar in that in connection therewith there has been adopted the foreign practice of banding it, in some cases with copper bands, and in other cases with steel wire. Other portions of the piping are made up of cast iron fittings and double extra heavy wrought iron pipe.

Some idea of the substantial character of this work may be gathered from the statement that the flanges for the 18-inch pipe are four inches thick.

But probably the most striking feature in connection with this piping is the absence of all gaskets. Every steam joint in the station is a ground joint and the claim is well founded that there is not a leaky joint anywhere about the plant. Experience has shown that the engineers of the station were justified in their views, that though the cost of grinding a joint is somewhat in excess of that made with a gasket, as to the durability of the two types there can be no comparison. Every engineer appreciates the constant attention required by joints, and to have this practically eliminated from the station duties is a matter of no small moment, not to speak of the constant loss due to leakage of steam.

Much attention has also been given in this station to the drip pipe system and it is claimed that the steam entering the engine is unusually dry. Certain it is that little trouble from wet steam has thus far been experienced.

Inasmuch as the engines are at present run non-condensing, the exhaust steam is first carried through feed water heaters, of which there are installed four 2,000 H. P. Goubert heaters and one 2,000 H. P. Wheeler heater. These heaters are probably the strongest thus far constructed. After passing through them the exhaust is carried into the main 32-inch exhaust pipes through which the steam finds its way to the roof by three 32-inch exhaust risers which are capped by large exhaust heads.

THE BOILERS.

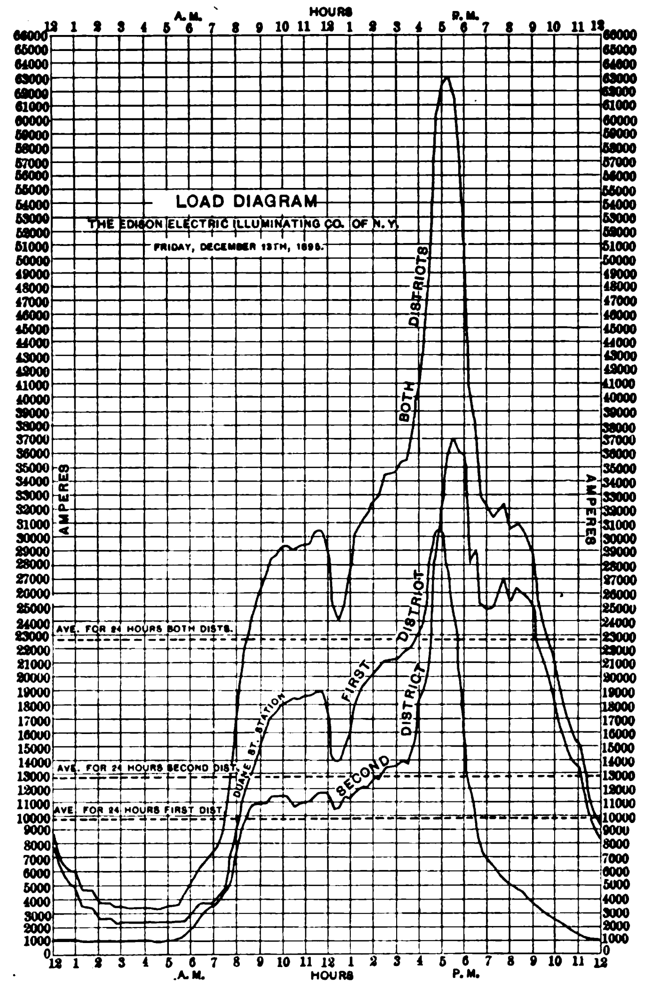
The boiler room, on the fourth story of the building, is a magnificently spacious room, extending from end to end of the building, 200 feet, and ventilated from both streets through the enormous central windows, shown in the view of the façade. A like condensation of power, to correspond with that in the operating room, has been accomplished by the use of huge "double-deck" Babcock & Wilcox water-tube boilers, some ten, and the latest twelve, rows of tubes high, built throughout of steel, designed to carry 200 pounds steam pressure and tested under hydraulic pressure to 300 pounds.

The boiler room, a view of which is given on page 31, contains at the present time twelve of these boilers having an aggregate of 47,472 sq. ft. of heating surface, which is about one-third the heating surface to be installed in the completed plant. All of the boilers are fitted so as to be used under forced draft when desired; and tests have shown that the boilers can safely be forced to over 100 per cent. of their normal capacity without serious loss in economy. It may be added that all the Company's stations are provided with Babcock & Wilcox boilers, aggregating in rated capacity 9,051 H. P.

COAL AND ASH HANDLING MACHINERY AND WATER SUPPLY.

The boilers are fed with coal—through weighing chutes, registering each hundred pounds delivered—from the enormous coal bunkers, occupying the fifth and sixth floors, and capable of carrying over 2,000 tons of coal at a height 96 feet above the street level. Here, as at other stations, several weeks' supply of coal is thus stored, to provide against emergencies arising from snow-blockades, miners' strikes or other difficulties, so that nothing may "freeze out" the customers' supply of light and power. The coal is raised from the street without manual labor, by the Link Belt Co.'s conveying machinery, operated by an electric motor.

With this system the coal is dumped from the street level



Load Diagram for the entire Edison System in New York, for Dec. 13, 1895.

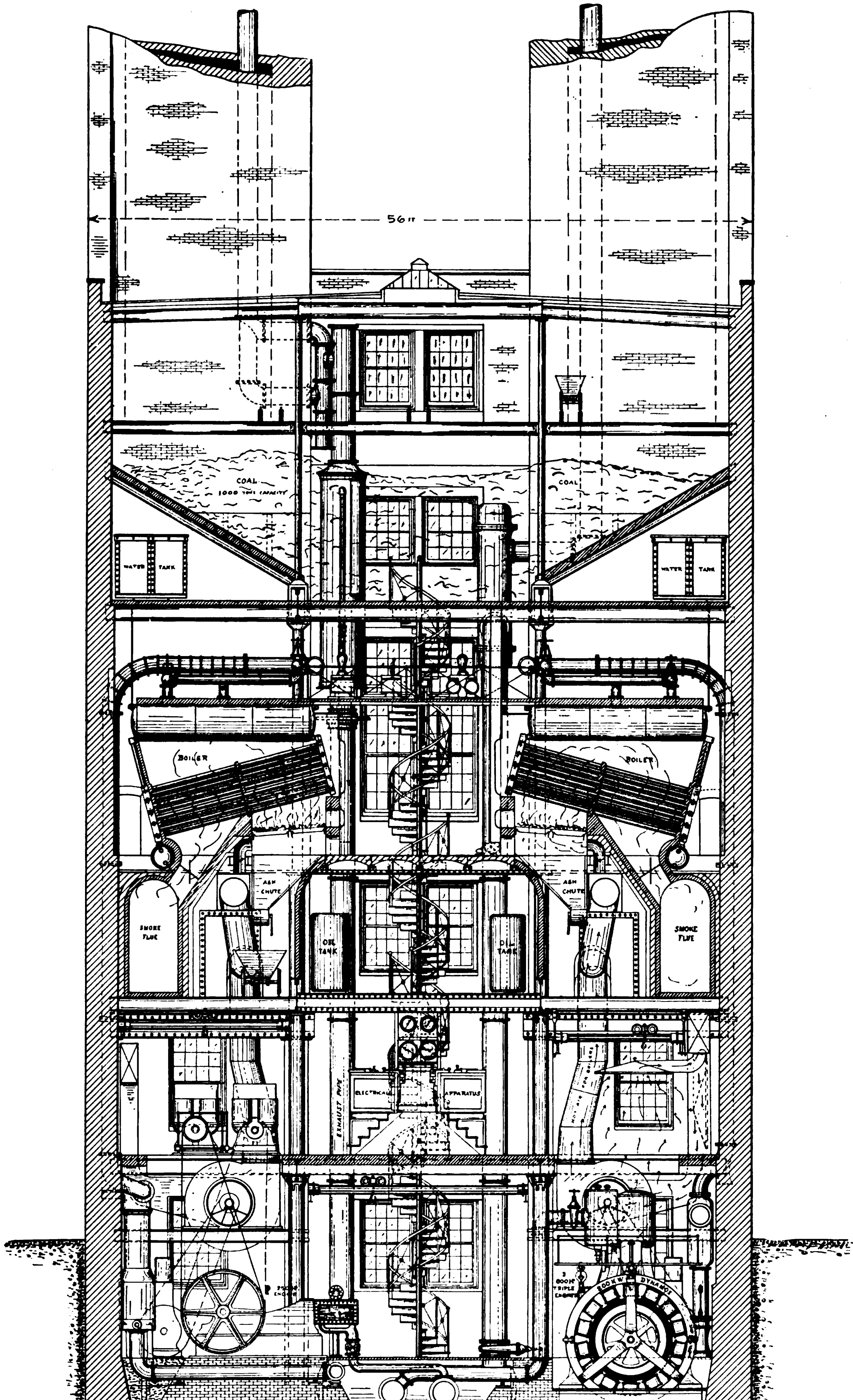
into a hopper suspended on scales, and after being weighed, is allowed to fall on to a screw conveyor which raises the coal to a series of buckets which carry it to the sixth floor and distribute it along the bunkers. Thence everything is done by gravity.

Directly under the boilers, and at the front end, are placed the ash hoppers, which discharge their ashes into ash cars on a tram-way below them. The cars are then wheeled to the end of the building and dumped into main chutes, which discharge directly into ash carts backed in from the street.

Provision has also been made for any sudden interruption of the water supply. For this purpose a series of large water tanks which are always kept filled for storage purposes, are placed on the same floor as the coal bunker. Besides being connected to the city water supply, the Company has wells of its own which can be drawn on for auxiliary or emergency uses.

THE SMOKESTACKS.

The construction of the smokestacks, by which the waste gases from the boilers are carried off, embody a number of unique features which have, indeed, attracted



THE 26TH STREET STATION, EDISON ELECTRIC ILLUMINATING CO., NEW YORK.—SECTION.

attention among engineers abroad as well as in this country Two stacks are employed, built of steel shells 14 feet in diameter, 140 feet long from end to end, 75 feet of this length projecting above the roof. Steel construction was adopted in view of the liability of brick chimneys to crack, especially under forced draft.

The peculiarity of the construction lies in the fact that the foundation, instead of being placed beneath the bottom flange of the steel stack, is placed on top of the bottom flange. This was done in order to save space below the chimney. The steel chimney projects up through the brick foundation and extends through a cap plate on top, around which are arranged a series of roller bearings which permit the steel shell to expand and contract independently of the foundation. This construction is illustrated in the engraving on page 28.

The steel shell is lined with fire brick, which is put on the shell in sections of about 14 feet in height. Each section of brick rests on a cast iron ring riveted to the shell of the stack. Each ring supports the section of brick directly above it, thus enabling any one section of brick to be taken out and replaced without interfering with the section above. This is a most valuable feature, permitting, as it does, of the lining at the bottom of the stack being repaired without interfering with that of the top. The entire chimney structure which begins at the floor above the boilers is supported by the side walls of the building and partly by the steel columns. The appearance of the stacks above the roof is shown in the engraving on page 28, and their close juxtaposition and elevated situation have gained for them the sobriquet of the "Heavenly Twins."

THE UP-TOWN STATIONS.

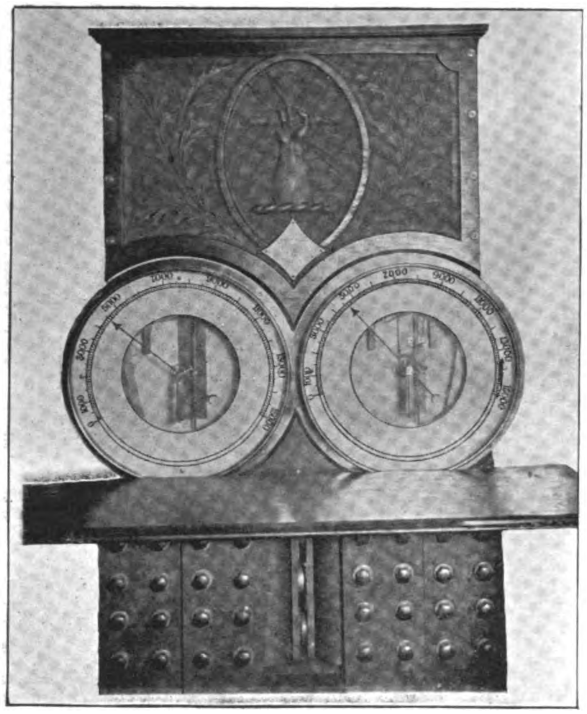
The down-town or first district is supplied now entirely from the great Duane street station, ("Old Pearl street" having been discontinued in 1894), except for occasional reinforcement on dark days or special emergencies by the "annex" for the Produce Exchange neighborhood. The line between the two districts is drawn nominally at 8th street, although the influence of the down-town station extends up-town and that of the up-town stations down-town, so that each part of the system supplements the other at the time of maximum load, which is a little later up-town than down-town.

The up-town or second district is supplied from the large central station in 26th street, which is now used to its full capacity and which like the Duane street station runs throughout the twenty-four hours, and also from stations in 12th, 39th and 53rd streets, which run for one watch of eight hours, or for two watches, varying with the station and with the season. In summer the 39th street station is now discontinued altogether.

All the stations from Duane street to 53rd street are connected by tie-feeders for the purpose of re-inforcing each station from the others and of supplying any local district when the immediate station is not in operation. By the use of a system of controllable disjunctive boxes, on a method planned by Mr. Bowker and worked out in detail by Mr. Van Vleck, these tie-feeders can be separated halfway between stations and thrown on to the mains by motors within the street boxes, operated through the pressure wires in the feeders from the station switchboards. This device permits the use of the tie-feeders for charging during the hours of minimum demand the storage batteries installed at the 53rd street and 12th street stations, and at the hours of maximum demand utilizes the feeders for direct local supply, almost quadrupling the current-carrying capacity of each feeder by thus shortening its length. The saving of investment in copper thus made possible is very large.

The 26th Street and 39th Street stations, completed in 1888–9, have often been described; the section plan is shown on page 35. It should be noted that many improvements have recently been made or are in progress at the 26th Street station, among which are the installation on the roof of a water-cooling tower of Worthington type and manufacture, in which condensing water is cooled by being dripped through thin iron tubes against a current of air which is forced upward by an electrically driven fan, thus enabling the triple-expansion engines to be run condensing, at greatly increased economy; the reconstruction and simplifying of the electrical controlling gallery, in the course of which the original "feeder equalizers" have been almost entirely discarded; and the use of the large Kelvin double ampere gauge, illustrated on this page, which measures the total current output of that station.

This instrument is probably the largest ampere-indicator ever constructed; it was built by James White, of Glasgow, and measures 15,000 amperes on each side of the system. It is worthy of note here that it is mainly due to the New York Edison Company that Lord Kelvin took up the large-dial volt- and ampere-gauges which are now being largely used abroad, especially in England. The instrument consists of a solenoid within which plays a soft iron core supersaturated magnetically by a coil of fine wire



THE KELVIN AMPERE-GAUGES, 26TH STREET STATION.

wound upon it. The opposing force is a spring whichh as been properly aged.

The 53rd Street station is not yet in its permanent form, but has been used to utilize the machinery transferred from the old Pearl Street station and elsewhere. It contains, however, the first storage battery employed in American electric light stations since the unfortunate experiences with storage battery systems some years ago. This is an English battery of the Crompton-Howell type, which has been found useful both as a reserve for use at the maximum period and as a regulator in continuous use to a small extent on the system.

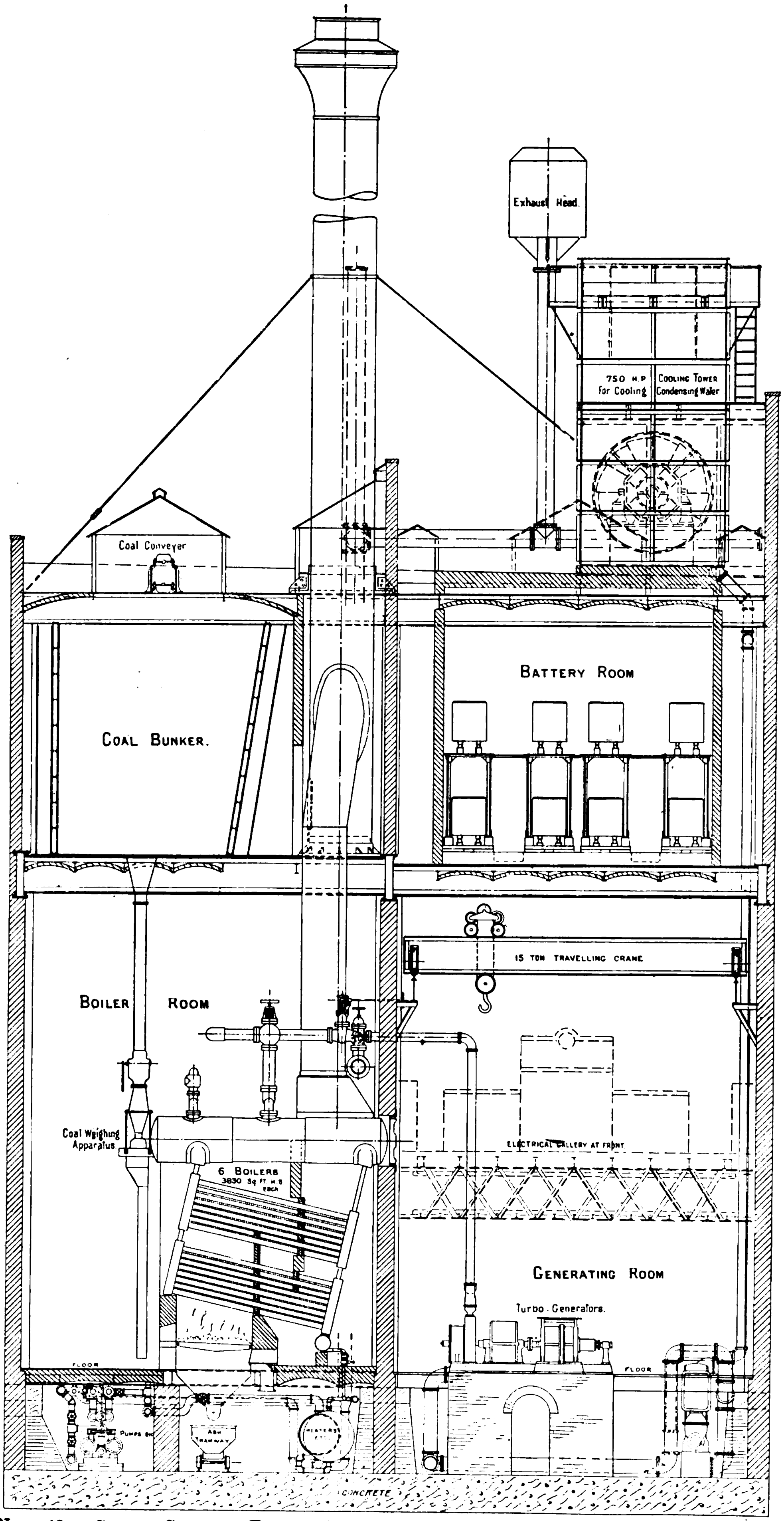
THE TWELFTH STREET STATION.

The 12th Street station, the building for which was completed with the close of 1895, is in many respects a new departure in station construction and therefore calls for special description It has been built, in preference to an extension of the 26th Street station, to supply especially the Union Square neighborhood and that part of the city a mile north of the Duane Street station, which is showing so much business growth.

FAÇADE OF THE NEW 12TH STREET STATION, EDISON ELECTRIC ILLUMINATING CO., NEW YORK.

It is planned to combine the advantages of a horizontal station—the preferable type where land is not too expensive—with certain features of the Company's vertical stations. The boiler room and the engine room are therefore both on the ground floor, dividing the ground space between them, and there is but one additional story, which over the boiler room is devoted chiefly to the coal bunkers and over the engine room provides for a storage battery of large size. The constructive feature of the station is the use of a skeleton or Chicago method of construction, the entire support being of Phoenix wrought iron columns, masonry being used only as curtain-walls. This construction, as utilized in this station, permits its extension either on the boiler room or on the engine room side by simply taking down the curtain wall and adding another row of structural columns on an adjoining lot. The façade is illustrated, from the architects' drawing, on this page.

The station occupies a plot of ground 60 by 100 feet



New 12th Street Station, Edison Electric Illuminating Co., New York.—Section.

and, as shown in the sectional view on this page, is divided, as stated, into equal parts which are taken up respectively by the boiler and engine room. Although all the apparatus is placed on the same floor level, it is planned nevertheless to get one H. P. on one square foot of real estate.

The boiler room will contain six specially designed Babcock & Wilcox boilers, having a total of 23,000 square feet of heating surface. These boilers are unusually high and short; they are of the high pressure type, of steel, and will carry 200 pounds pressure. The steam piping is designed to effect the shortest possible connection between boilers and engines. Over the boiler room are placed the coal bunkers and coal elevating machinery of the Jeffrey type.

The three smoke-stacks are of characteristic construction, being built of sheet steel, 90 feet high, erected without brick lining, each stack to furnish draught for one pair of boilers, thus avoiding horizontal smoke flues. The stacks are prominent features of the neighborhood, and have been nicknamed the "Three Graces."

The generating room, immediately adjoining the boiler room, is designed to have an ultimate capacity of about 6,000 H. P. A radical departure in the engine equipment will be inaugurated by the installation, as the first permanent unit, of a 300 H. P. De-Laval steam turbine which will drive two multipolar dynamos. The illustrations on page 40, show this turbo-generator in plan and side view.

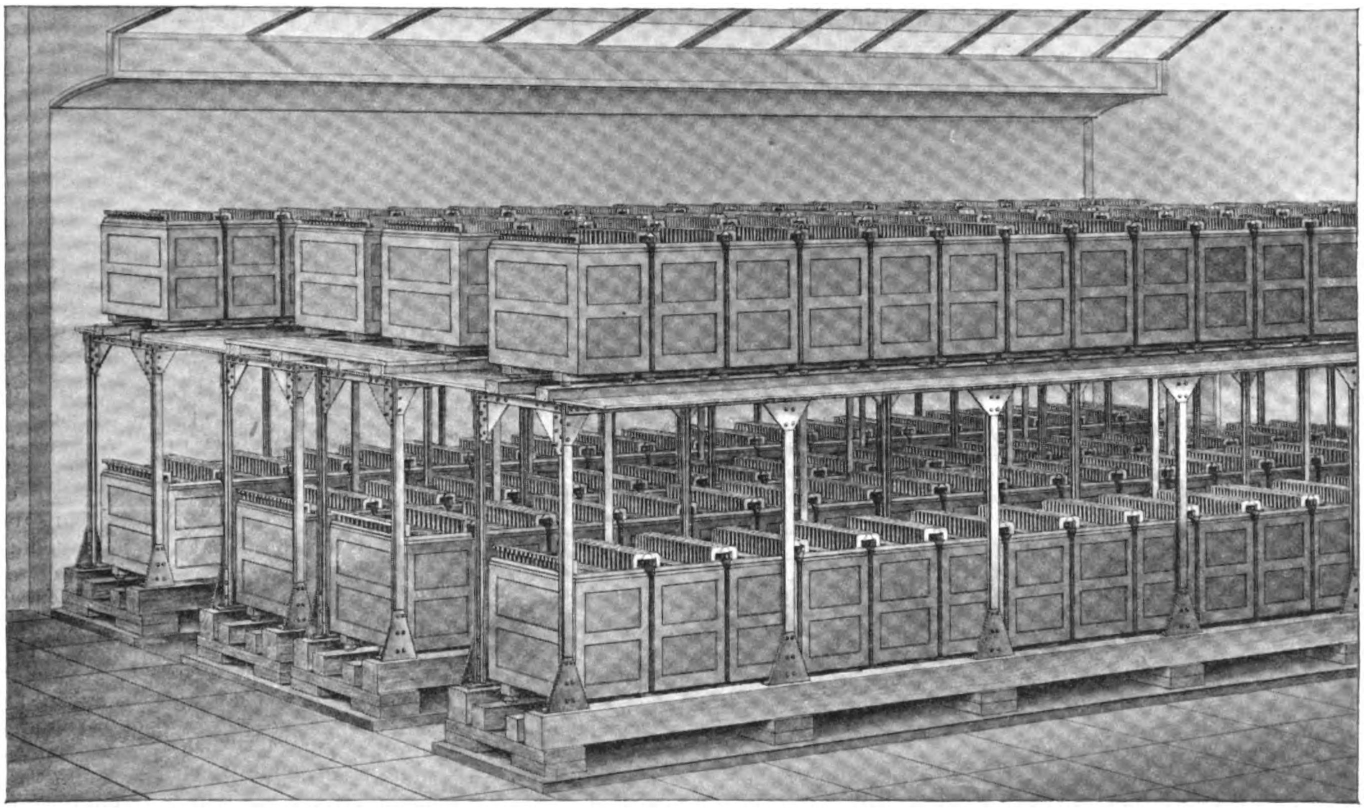
In thus installing a new type of generator, never before commercially used in this country, the Company has again shown its enterprise and the progressive spirit of its management, and thus added another to the many obligations under which the electric lighting fraternity of this country rests to the New York Edison Co.

This station will be run chiefly with engines condensing, and the water for that purpose will be cooled in a Barnard water cooling tower placed on the roof. One of these cooling towers has a capacity of 750 H. P. and space is available for 3,750 H. P. additional. The cooling of the water is effected by blowing air through a series of wire mats down which the condensing water is allowed to trickle. The blower for this purpose will be operated by an electric motor, direct connected to its shaft.

At the south end of the station extending over the front entrance is the gallery for the electric controlling apparatus. The Van Vleck edgewise system, similar to that employed at Duane Street, will be used with the addition of the necessary equipment for operating the storage batteries.

THE STORAGE BATTERY AT 12TH STREET.

Above the electrical gallery and directly handled from it, is the controlling board for the storage battery, separating the battery room proper from the booster room. The battery room at this station, which is shown in the illustration on this page, contains, arranged in two tiers, upon a floor space of 22 x 42, 150 cells of a capacity of 8,000 ampere hours, when discharged at the ordinary voltage, or 4,000 amperes at the double voltage across the system. This has required the use of unusually large cells, each of which contains 19 positive and 20 negative plates, the positive plates being of the pasted grid (Tudor) type and the negative plates of the Chloride type. The entire installation is supplied by the Electric Storage Battery Co. of Philadelphia.



STORAGE BATTERY ROOM IN 12TH STREET STATION, EDISON ELECTRIC ILLUMINATING CO., NEW YORK.

The installation of this storage battery, at this nearly central point of the system, is part of an interesting general plan, which may ultimately include also storage batteries in annex stations near the extreme ends of the system.

The tie-feeders are arranged, as explained, so that the 12th Street station may be connected directly with the Duane Street station or the 26th Street station, and the battery can thus be charged from either of those points at ordinary voltage, by help of the "booster" located in front of the battery room, the direct current Edison system enabling the Company to avail itself of this method of accumulating reserve. This enables the Company to utilize its generating machinery at either of these stations during the minimum hours and at times when engines are running with but partial load, with great increase of economy in operation. It is intended to run the generating machinery at the 12th street station only during one watch of maximum demand, and to supplement this supply during maximum hours with current from the battery. The battery will also supply this part of the city, during hours when the 12th street station machinery is not run.

It is also useful as a reserve for the entire system, and it may help to make possible the shutting down of the Duane Street station from Saturday night to Monday morning, and perhaps limiting its operation to two watches instead of three. The possible uses of a storage battery, it will be seen, will be thoroughly worked out in this interesting installation.

THE UNDERGROUND SYSTEM.

Mr. Edison, with wise prevision, early foresaw that the great cities must ultimately require all electric conductors to be laid, like the gas and water systems, underground. Accordingly, with the co-operation of Mr. John Kruesi, he worked out a complete underground system, so that when the inevitable controversy came in New York the Edison Company was safely beyond criticism from the city authorities. His plan, as is well known, was to lay mains in front of the houses on each block, joined at the street corners into a crib or network, and to supply current to this system of mains by feeders running from the central station to different points on the network. Of his original "two-wire system" 4½ miles of feeders and 10½ miles of mains were laid altogether, in the down-town district.

After the "two-wire system" had been laid, Mr. Edison invented his "three-wire system" of distribution, one of the most important developments in the electrical industry, which, by introducing a third wire, made it possible to double the working pressure, to greatly decrease the copper necessary for a given output of current and, by lessening the "drop" or energy losses, to greatly extend the area of supply. All the up-town district, as it was developed, was installed on the three-wire system, which is carried not only throughout the street system but also through house installations, incandescent lamps being nearly evenly

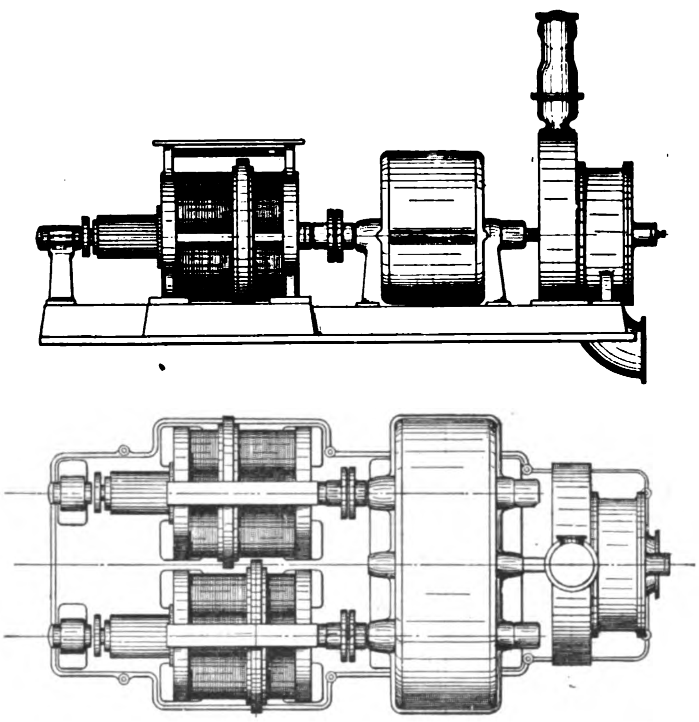
"balanced" on the positive and on the negative sides. The two-wire system has been almost entirely re-laid and the three-wire system has been extended till the Company to-day has, as already stated, over 203 miles of ducts, containing 608 miles of copper conductors, under the pavements of New York City. A map of its system of mains is given with this article, in the supplement.

The standard sizes employed for mains are 150,000 C. M., 200,000 C. M. and 350,000 C. M. in area. In the mains the neutral wire is of the same cross-section as the outside wires, while in the feeders, running from 400,000 to 1,000,000 C. M., the neutral wire is one-third the area of the other two.

Edison tubing is the standard type of underground conductor employed, but a small quantity of Siemens iron armored cable, made by the General Electric Co., at Schenectady, has also been laid down as feeders radiating from the Company's 53d St. station.

On the New York Edison system the voltage is approximately 120 volts on either side, or 240 volts between the outside conductors, incandescent and arc lamps being placed on the lower voltage and motors usually on the higher voltage. But one system of conductors is used for incandescent and arc lighting, for power and for heating and kindred purposes—an advantage which has gained for the Edison system much of its commercial success.

The Company brings its service inside the front wall of a customer's house, protecting it at the end by a service-end box designed by Mr. Van Vleck, or by the Van Vleck cut-out, either of which is so arranged as to make it easy to shut off all electrical connection between the house and



Dynamos. *Reducing Gear.* *Steam Turbine.*

THE DELAVAL STEAM TURBINE, 12TH STREET STATION.

the street system, when desired; and it furnishes also, to be set by the wiring contractor, an Edison meter for measuring the amount of current used by the consumer. An illustration of the most modern devices for service connection is shown on this page.

The consumer is protected against abnormal flow of current not only within his house, by means of the fusible safety-catches invented by Mr. Edison as a part of his original system, but by successive safety-catches throughout the street system. There is one set between the house and the street service; another set between the mains and the junction boxes at the street corner, into which, when they are "feeder-end boxes," the feeders run from the station; another set at the feeder-ends, and finally there is a set within the station itself. In this important feature electric supply has a decided advantage over gas supply, which has no such automatic cut-out.

Another advantage of the Edison underground system

SERVICE CONNECTIONS ON CUSTOMER'S PREMISES.

to the consumer in New York is that the system of network gives usually a double supply from either end of the street as well as a supply originating from several stations. Thus, if anything happens to one main, or to any one feeder, or indeed to any individual station, the consumer does not lose his supply as he would on the ordinary single loop system.

The feeders enter the station from below the surface of the street, coming through the wall of the vault, taking the Duane St. station as an example, in pipes 6 inches in diameter, as shown in the engraving on the opposite page. Passing upwards they are run along the ceiling supported between porcelain knob insulators, after the manner shown, and are then led through the cable runway, shown in the sectional view, which runs the entire length of the station. These runways consist of piers built up of brick in which earthenware pipes are laid in cement. Through these the stranded cables connected to the feeder ends are led to a point directly below the electrical gallery, and in these runways also are carried the cables connecting the various machines with the electrical gallery. Stranded cables insulated with rubber are used for this purpose. A cable vault is located at each end of the station, that on the Duane street side for the feeders running south, and that on the Pearl street side for those running north.

THE METER SYSTEM.

One of the fundamental principles laid down by Mr. Edison governing central station work, was that the customer should be charged for the exact amount of current used, and that the method of charging by contract ought to find little place in a properly managed current distributing establishment.

When Mr. Edison began the development of his system, there was no commercial method of measuring, at the consumer's premises, the current supplied for his use. His

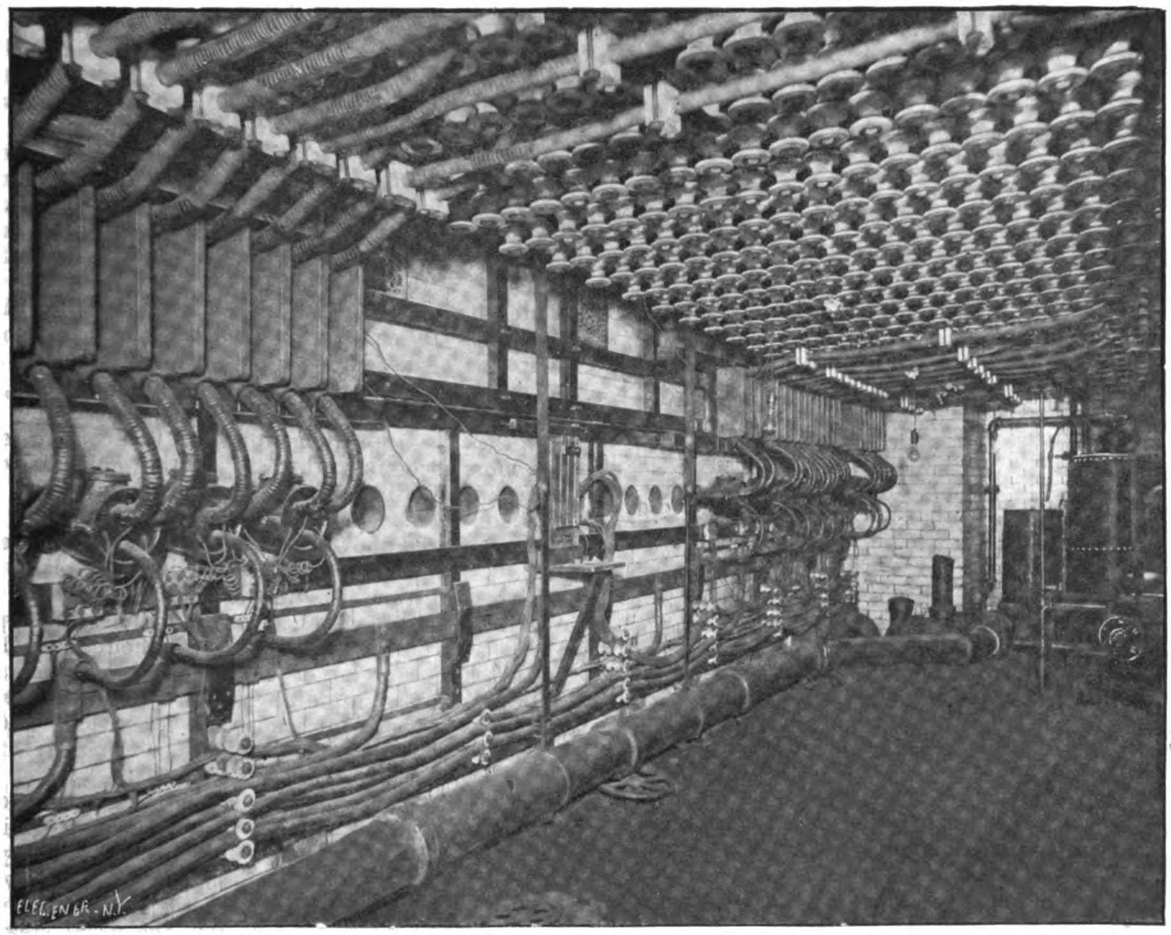
fertile brain promptly devised several practicable meters, mechanical and chemical, from which he selected his well-known electrolytic ("chemical") meter as meeting with accuracy both scientific and commercial requirements. It had the one disadvantage that it could not be read directly by the consumer, but necessitated the weighing of the plates. The New York Company has recognized the desirability of this feature of an ideal meter, but has not yet found any type combining direct reading with the accuracy and simplicity of the Edison "chemical" meter; so that all current delivered on its system is still measured by this means.

A glance at the engraving on page 42 will illustrate the simplicity of the principle of Mr. Edison's well-known meter. A glass bottle contains two zinc plates, immersed in a standardized solution of sulphate of zinc. The electric current enters the bottle from the terminal of one plate, passes through the solution and goes out through the terminal of the other plate. In so doing it disintegrates from the "losing plate" particles of zinc and deposits on the "gaining plate" their exact equivalent. The amount thus transferred is in exact proportion to the amount of current passing through the bottle, according to a well-known physical law. The quantity of current shunted through the bottle is a definite proportion of the quantity going directly into the house, "resistances" within the meter fixing the exact proportions. The exactness of this proportion is verified before the meter is placed on the system, and can be checked at any time by electrical tests on the consumer's premises.

Each three-wire meter contains two pairs of bottles, one pair on the positive, the other on the negative side of the system. The same amount of current passes through each bottle of the pair and by weighing the "gaining plate" in one bottle and the "losing plate" in the other, a double check is obtained.

After a meter is installed on a customer's premises it is then sealed until the next round of the "meter-wagon." The Company's representative unseals the meter, removes the bottles, replacing them by others whose plate-weights have been carefully recorded, and brings the four bottles in a four-part box back to the Meter Department. Each meter has its proper number; each bottle-box has an identifying label which bears the record of the bottle-changing and meter-inspection; and the plates within the bottles are also specifically numbered—so that confusion between the records of different consumers is practically impossible.

All the meter work of the Company is concentrated and organized in the Meter Bureau at the north end of the eighth floor of the Duane Street Station. The whole establishment is so arranged, with glass partitions, that each process of weighing, calculating and verifying, though handled in separate offices, is under the direct eye of the superintendent as he sits at his desk.



THE NORTH FEEDER VAULT, DUANE STREET STATION, EDISON ELECTRIC ILLUMINATING CO., NEW YORK.

As the bottles come in from the day's trip the plates are taken out, carefully dried and passed on to the weighing room, while the solution is decanted, filtered and re-standardized in an ingenious series of tanks from which it is delivered, at the proper standard, through four faucets filling all four bottles at once.

Meanwhile in the weighing room, carefully trained weighers, most of them girls, using Becker's balances of the finest accuracy, record the weights of the plates, on the consumer's meter card, and a second weigher makes an independent weighing, the results of which are compared with those of the first. This meter card also gives the weight of the plates as they went out to the consumer, and

the differences in weight, carefully reckoned from charts previously calculated, to prevent clerical error, and accurately verified, are made the basis of the bill charge. The consumer's card thus contains the history of each charge, doubly checked at each point with the initials of each person concerned, furnishing evidence directly available to the consumer, or in the courts should bills be questioned.

The incoming plates, having been weighed, are then cleaned and re-weighed with similar precautions, numbered, and recorded on the consumer's card as they go out in the bottles intended for his meter.

The Company has taken the utmost pains to make its meter system absolutely accurate, within the limits of human fallibility, and the few errors in bills which are found in the course of a year, are easily traced and corrected. Questions are always raised, and always will be raised, as to the accuracy of any kind of meter, gas, water or other, and the N. Y. Edison Company meets this point by opening its records and showing all its meter operations to any consumer who wishes, and by enabling him, if he desires, to follow the plates of his own meter from his house to the desk of the bill-clerk.

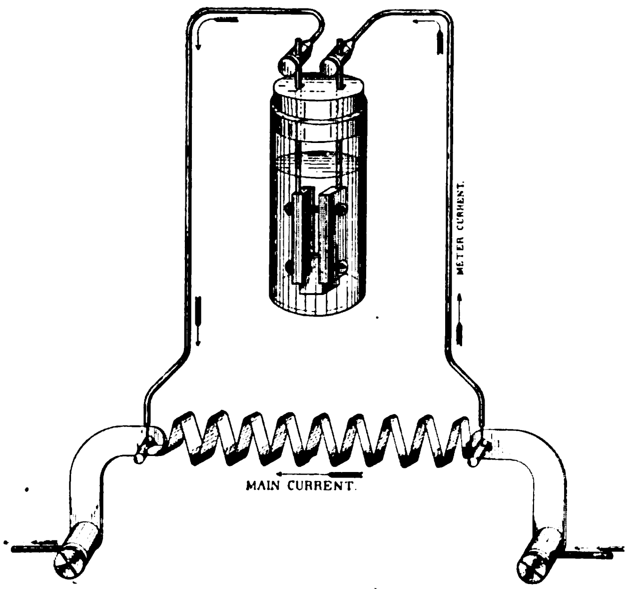


Diagram Illustrating Principle of Edison Meter.

The identification and double checking at every operation are wonderfully complete; and no employé can have motive or opportunity for modification, either for or against the Company, of the correct result.

USES AND PRICE OF CURRENT.

The uses of the continuous low tension current cover almost every service to which electricity can be put. The rates charged by the Company vary according to the nature of the service, but are almost without exception based on actual meter records, and they are the same to all customers for the same class and amount of service. From the very beginning the Company has encouraged the liberal use of light by the inauguration of a graded system of discounts depending upon the amount of current taken.

The basic price of incandescent lighting has been brought down throughout the system to the uniform rate of one cent per (16 c. p.) lamp hour, including the supply of incandescent lamps, and in addition to discounts depending on the amount of bills (on those over $100 per month) the Company has introduced within the past year additional discounts, on bills over $200 per month, dependent on the average amount of burning (if over 50 hours per month) of all lamps installed,—a system since followed by the other electric light companies in New York City. By thus increasing discounts, the Company has voluntarily and continuously reduced the average price of current for electric lighting, and by offering inducements to large consumers to take station current instead of installing isolated plants, it seeks to increase its output without proportionate increase of expense, with the aim of ultimately giving to all consumers, small as well as large, the benefits of reduced prices. This is the declared policy of the administration of the Company, which aims to divide the benefits of new economies and improvements fairly between consumers and stockholders.

The result of this system is that the largest consumers are obtaining current at the rate of 8 cents per kilowatt hour, including supply of lamps. We doubt whether an isolated plant even of the largest size can be found which can show a lower cost than this, when all the items that go to make up the cost of electric lighting are considered. Indeed the owners of new large buildings now erecting in New York are more and more realizing the fact that, considering the initial cost of installation of engines, dynamos, boilers, pumps, together with the cost of coal, attendance, repairs, etc., it is cheaper to take current from a central station, whose sole business it is to manufacture current at the highest possible economy,—in contradistinction to the light, wasteful load which isolated plant dynamos generally carry for the greater part of the day's run.

The same principle of graded discounts applies to arc lighting, which department of the Company's work has made rapid strides during the last few years. The rate of charge is 10 cents per hour for each 8 ampere arc lamp, with discounts which brings the cost down to 6½ cents per arc lamp hour, including lamps, carbons and attendance, and to 5½ cents, where the customer furnishes the latter items himself. It is coming to be more and more recognized that arc lighting holds its own as the cheapest of all illuminants, despite all the recent improvements in the use of gas.

We referred above to the gradual recognition of the fact by owners of buildings that isolated plants were not paying investments; all the arguments there used and many more can be applied to the innumerable applications of motive power scattered throughout a modern city. Indeed the supplying of current for motors has advanced with enormous rapidity within the last few years, and at the present time no less than 12,000 H. P. in motors are supplied by the Company from its service. Among the purposes to which electric motors are largely applied are passenger and freight elevators of which no less than 300, aggregating 3,000 H. P., are now being operated from the Company's mains.

The reason of the electric motor's popularity for this particular purpose will be readily understood when one stops to consider that by its use the usual steam engine plant and all its attending cost and nuisance are wiped out of existence, and in their stead we find a neat machine, with but a single moving part, tucked away in a corner of the cellar, or bolted to the beams under the roof, which requires no attention whatever from the owner, who for a small monthly fee, can transfer the entire care of the machine to the central station. And all this luxury, for such indeed it has come to be, can be had for 10 cents per H. P. hour, with discounts which bring the cost down to 5 cents per H. P. hour for customers using 1,500 H. P. hours per month.

Besides the elevator work above referred to, the Company furnishes current for hundreds of electric motors driving printing presses, pumps, sewing machines, lathes, planers, organs, grip hoists, exhaust fans, table and desk fans, and for scores of other purposes. The Company leaves the customer free to install his own motor, with the result that there are no less than 40 different makes of machines connected to its circuits. For all purposes requiring a small quantity of power, the electric motor is conceded to be not only the most economical but the most

convenient of any thus far devised. Its introduction in many small industries has not only greatly increased the output but has made the work lighter and in this respect is beginning to make itself felt as one of the factors making for increased comfort among the masses of toiling humanity.

To the above uses must be added that of electric heating and cooking, for which increasing amounts of current are being called for month by month. The rates for this service are the same as those for motive power.

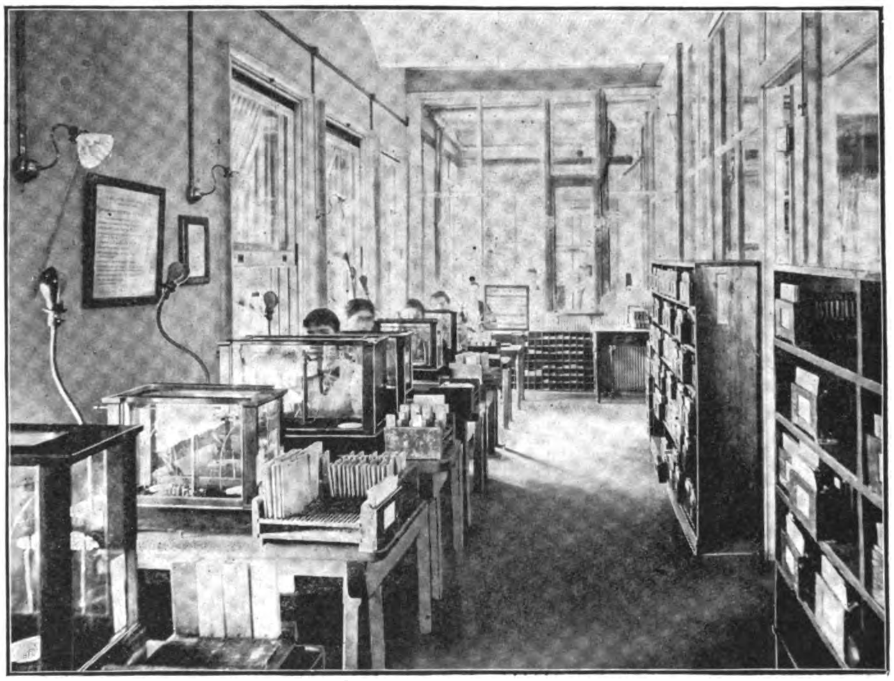
GENERAL VIEW OF METER DEPARTMENT.

THE INSPECTION DEPARTMENT.

It is through the Inspection Department that the Company comes in most direct contact with its customers. On the Inspection Department first of all devolves the work of providing for new customers. After an application blank for current service, has been signed by the customer and the usual contract made with him, an order to make the required connection is given to the Installation Department, which carries the mains to the service outlet in the cellar or vault of the building to be lighted. The Edison Company itself does no wiring whatever of buildings, preferring to allow its customers to have this work done by outside contractors. As, however, it is necessary to guard against bad wiring work, which might cast discredit upon the system, the Company before turning on current makes an inspection, in co-operation with the New York Board of Fire Underwriters and the New York City Electrical Inspection Bureau. The Company's inspection is made particularly with reference to the service rules relating to the balancing of the system, the metering and division of current for light, heat and power and the proper placing of switches, cut-outs, etc.

To this department also are referred all customers' complaints. If, for example, a customer complains that his bill is too high, an inspector is sent to investigate. The records are examined, and frequently a special test is made on the customer's premises. Where the current is used for power purposes the mechanical plant is examined, as it has been often proved that much current is consumed or rather wasted in driving badly-erected and ill-lubricated shaftings. A leakage test of the wiring is also made to determine any loss in this direction. In addition to its regular inspection work, the Company for a slight charge undertakes the weekly inspection of motors and thus relieves the customer of burden in this respect.

One of the many other interesting features of the work of this department is the system of card indexes systematically registering the great variety of details of the Company's business. A card index of customers gives on each card the full data as to each customer's installation; this is supplemented by a card index of work in progress, showing by the arrangement of the cards in separate trays, the exact status of each installation which is to be connected to the Company's system—which cards fall into place in the customers' index when the work is completed. The entire city within the limits of the Edison system is mapped on another set of cards, each of which is to record the data as to the houses on each block-face and their relation to the Company's underground system. This is paralleled by another card index showing the data relating to the street mains on each block-face, including their electrical capacity and condition.



VIEW IN WEIGHING ROOM OF METER DEPARTMENT.

For some years electricity shared with "rats" and "spontaneous combustion" the responsibility for fires of unknown origin, and the false notion of danger from fire thus arising led to the keeping of a card index of fires by the Edison Company which gives a report of every fire in buildings within the electrical district, which has resulted in showing how few are the number of fires caused in any way by the electric current. A comparison of this record with fires caused by gas or matches would be interesting.

We might fill several pages describing these highly interesting records, which mean so much for the present

as well as the future development of a Company of this nature, but we must content ourselves with mentioning but one more feature, the General Survey, which was completed within 1895, and which was undertaken in order to enable the Company to know the lamps; the number and make of motors, their horse power and the uses to which they are put; together with other information of like nature. It must be evident that the making of such a survey of a system embracing nearly 7000 customers entails a heavy expense, but the information

Table Showing Boiler, Engine and Dynamo Capacities of the Edison Stations in New York.

Stations.	Boilers. No.	Make.	H. P.	Total H. P.	Engines. No.	Type.	Size.	H. P.	Total H. P.	Dynamos. No.	Kilo-Watts.	Amperes.	Total Amperes.
Produce Ex.	Steam supplied by the Produce Ex.			250	1	McIntosh & Seymour.	18½ × 18		200	2	100	500	1,000
Duane Street	11	Babcock & Wilcox	325	3,575	1	Van Vleck.	26–37–52–72 × 36		Floor. 2,500	2	800	6,000	12,000
					2	"	24–35–52 × 36	1,250	2,500	4	400	3,000	12,000
					3	"	18–27–40 × 30	600	1,800	6	200	1,500	9,000
					1	McIntosh & Seymour.	18½ × 18		250	2	100	700	1,400
									7,050				34,400
"B." Being erected.	"B." 1	"		553	"B." 1	Southwark.	29–38–54–72 × 39		2,500	"B." 2	800	6,000	12,000
Total capacity 1st District				3,825					7,250				35,400
12th Street	1	Babcock & Wilcox		333	1	Armington & Sims.	21 × 18		450	2	175	1,250	2,500
"B." Being erected.	"B." 2		333	666	"B." 1	McIntosh & Seymour.	20–32 × 18		500	"B." 2	175	1,250	2,500
26th Street	14	Babcock & Wilcox	184	2,576	3	Van Vleck.	18–27–40 × 30	600	1,800	6	200	1,500	9,000
					5	Armington & Sims.	18½ × 18	250	1,250	10	100	700	7,000
					3	McIntosh & Seymour.	15–23 × 17	250	750	6	100	700	4,200
				2,576					3,800				20,200
39th Street	9	Babcock & Wilcox	163	1,467	6	Armington & Sims.	18½ × 18	250	1,500	12	100	700	8,400
					1	N. Y. Safety.	18½ × 18	250	250	2	100	700	1,400
		Down Stairs			1	"	15½ × 16		200	2	60	450	900
					1								
					1	Straight Line.	15 × 16		150	2	60	400	800
									2,100				11,500
"B." Being erected.	"B." 1	Babcock & Wilcox		163									
53d Street					1	Straight Line.	15 × 16		150	2	60	400	800
	1	Babcock & Wilcox		163	1	N. Y. Safety.	15½ × 16		200	2	60	450	900
	3		240	720	1	"	"		200	2	60	450	900
				883	1	"	"		200	1 1	60 100	450 450	900
	"B." 1 (half)	"		120	1	"	14 × 16		150	2	60	450	900
									900				
1–140 Cell Storage Battery having an Ampere capacity for 1 hour of													1,000
													5,400
Two 30 K.-W. Dynamos are used for changing the Battery and are driven by a 50 K.-W. 250 Volt M. P. Motor.													
Total Capacity 2d District				5,259					7,250				39,600
Total Capacity both Districts				9,084					14,500				75,000

"B." Being erected. Dec. 1, 1895.

exact extent and condition of its customers' installations. What this survey shows can be demonstrated in no better way than by the form appearing on page 47, which gives the record of the Metropolitan Opera House installation in New York, the current for all purposes in which is furnished from the Company's mains, constituting without doubt the largest installation of this kind in the world, supplied from a central station. As the form shows, tests are made of the insulation of the system, nature of conductors, switches, sockets, etc., number of lamps of different candle power, and their equivalent in 16 c. p. it places in the hands of the Company is well worth the outlay.

THE ENGINEERING DEPARTMENT.

A company which is so rapidly extending its work naturally requires an engineering staff and the constant keeping of records of its work. The Engineering Department, with its Bureau of Maps and Records, is located on the eighth floor of the building; a view of one of the rooms is given on page 45. Here all the designing and engineering of the company are carried on and all con-

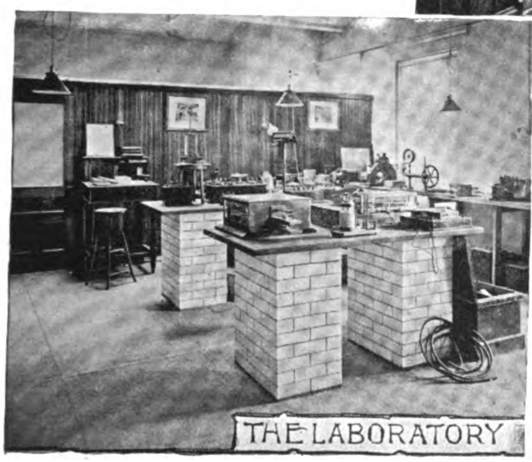
struction records kept, together with those of the laboratory which forms a part of this Department.

An excellent system of maintaining the maps of the distributing system up to date is here employed. It is frequently necessary to furnish blue prints of these maps both to the public and to wiring contractors and as changes occur almost every week it would be a matter of no small import were it necessary to make a new tracing whenever a change occurred. This has been very neatly obviated by the employment of a process patented by Mr. J. C. Elder of the Company's engineering staff. The blue prints are made from a glass plate which is covered with an opaque solution. The city map together with the existing distribution system is traced on the plate by means of a stylus which scrapes away the opaque surface, thus leaving the plate as a direct positive from which blue prints can be made. Whenever a line is extended it only becomes necessary to scrape away the opaque surface from the plate; or, on the other hand, should a line be abandoned or a change made, by painting over the existing line the trace will disappear. This process has given the greatest satisfaction and has been adopted by several large electric light companies for similar work.

In this department also there is kept an elaborate system of street locations on maps drawn to a scale of 25 feet to the inch, which show the location of every tube connection and junction box in the Company's entire system.

THE LABORATORY.

In a company, the success of whose work depends so largely upon the maintenance of constant pressure upon its system, and on the other hand which employs so much auxiliary apparatus, it becomes a matter of vital importance to maintain the accuracy of its indicating instruments and to test all apparatus submitted to it by manufacturers. For this purpose there has been equipped a laboratory, the principal function of which is to keep standard and in repair all the electrical measuring instruments of the Company. It also loans to the various departments testing apparatus needed by each and, in addition, carries on the testing of incandescent and arc lamps and other miscellaneous work, being equipped with a photometer room for that purpose. Among the standard apparatus here used we noticed two Kelvin balances one of 2,500 amperes and the other of 250 amperes capacity, besides a full complement of standard galvanometers, resistances, etc. The work of this department will be appreciated when it is stated that it is required among other things to keep standard no less than eighty portable Weston ampere and volt meters of various types in use by the inspectors and in the various departments of the Company.



THE LABORATORY

MAIN OFFICE HALL

METHOD OF KEEPING ACCOUNTS.

Interesting as it is to follow out through their various ramifications the details of the numerous technical departments and the working apparatus of the Company, nevertheless the statistical work of the Accounting Departments presents features of no less importance and value, especially to central station managers. If a canvass were made of the central stations operating in the United States at the present moment, it is doubtful if one in a hundred would be found to possess the data requisite to determine exactly what each part of the work of generating and distributing electric current costs; and yet this knowledge is most essential and indeed the first requisite as a guide to improvements and increased economy. The New York Edison Company has carried out this work in a manner not excelled by any similar organization in the country, in proof of which we need only refer the reader to the tabular arrangement shown on the page following, which gives the various items into which the accounts are subdivided. These details are grouped under the heads of "Operating," "Construction" and "Ledger Accounts." The first of these, "Operating," occupy the first six columns. In the four succeeding columns, we find the Construction and Ledger accounts, similarly subdivided. It will be noted that the decimal system of classification is employed, similar to that used in connection with The Electrical Engineer Data Sheets. Thus each of the ten main divisions in the three departments, is designated by a single digit ranging from 0 to 9. Each sub-division under any particular division is then designated by two digits, the first of which is the one designating the main division. Where it is necessary to again sub-divide, a third digit is added. Thus an item numbered, let us say, 433, would at once be recognized as relating to the renewal of incandescent lamps in the division of "Distributing Maintenance."

BUREAU OF MAPS & RECORDS

The minuteness with which this scheme has been carried out as exhibited in the schedule on page 46 must command general admiration. Its faithful maintenance makes it an easy matter to determine at any time the exact working condition of the company.

Among the reports furnished from each station is that shown in blank form on page 48, which gives the details of the operating department for each week.

These reports, together with others which the limits of space forbid us to describe in detail, enable the tabulation of the monthly statistics of cost reduced to the basis of the kilowatt hour. With such a form filled out, before him, the Executive can trace the work of the station month by

month and note the effect of any change due to management or to improved apparatus installed.

ADMINISTRATION.

From what has preceded, it is evident that to maintain in proper working order an organization having such important public functions and involving such a mass of detail requires most exact and complete administrative organization. It is safe to say that in this respect, the New York Edison Electric Illuminating Co. is not surpassed

the offices of the Secretary and the Assistant General Manager, and on the eighth floor the Council Room, etc. It is intended that this part of the building shall be fitted electrically like a private house, so that the visitor will find here the various electric features, on the most improved plan, of a modern residence. A library of electrical books and an electrical kitchen will be among the features.

As the visitor enters the central hall, which is illustrated on page 45, he finds immediately to the left a bureau of information where the attendant receives messages and

A Lower Dist.	B Both Dist.	C Upper Dist.	D Duane St.	E Produce Ex.	F 12th St.	G 26th St.	H 39th St.	I 53rd St.	M Manhattan.
OPERATING.						CONSTRUCTION.		LEDGER ACCOUNTS	
General Expense Office. 0.	General Technical. 1	Production. 2.	Repairs. 3.	Distributing Maintenance. 4.	Distributing Repairs. 5.	Construction. Stations. 6.	Construction. Districts. 7	Supplies 8	Miscellaneous 9.
00 Sundries. 1 Rentals 2 Lighting & Heating. 3 Meals. Car Fares 5 [illegible] 6 Ice 7 Interest &c. 8 Bond & Stock Expenses	10 Meter Sundries.	20 Sundries Ex. 1 Rentals. 2 Lighting & Heating. 3 Meals. 4 Car Fares. 5 Post [illegible] 6 Ice.	30 Sundries. 9 Furniture & Fixtures.	40 Sundries.	50 Sundries.	60 Sundries.	70 Sundries. 7 Laboratory Apparatus. 8 9 Tools & Implements	80 Sundries.	90 Sundries
01 Executive. 1 Directors. 2 P. V.P. S. & T. 3 Asst. Gen. Man'r.	11 Meter, Labor (Maintenance)	21 Superintendence & Care. 1 G.G. Supt 2 Dist. Supts. 3 Assist. Supts. 4 Clerks & Office Boys. 5 Janitors &c	31 Salaries & Wages. (undistributed)	41 Salaries & Wages. 1 Junction Boxes. 2 Annual Survey 3 Service Ends. 4 Watching Openings.	51	61 Salaries & Wages. (undistributed)	71 Salaries & Wages. (undistributed)	81	91 Labor. (outside parties)
02 Accounting Dep't 1 Auditor 2 Cashier. 3 Book-k. & Clerks. 4 Collectors.	12 Meter Repairs 1 Labor 2 Supplies 3 Misc.	22 Boiler Labor. 1 Firemen. 2 Pump & Heater Men. 3 Cleaning 4 Coal Handlers. 5 Ash Handlers.	32 Boilers. (including labor) 1 2 Grate Bars. 3 Tubes.	42	52	62 Boilers.	72	82 Supplies - Material	92 Material (outside parties.)
03 General Service. 1 Controller 2 Order Clerks. 3 Stenographers. 4 Hall Boys 5 Janitors. 6 Supply Room Wages.	13 Meter Supplies 1 2 Sulphate. 3 Mercury. 4 5 6 Ice.	23 Engine Labor. 1 Chief. 2 Engineers. 3 Helpers. 4 Machinists 5 Oilers. 6 Wipers	33 Piping (including labor)	43 Incand Lamps. 1 Labor. 2 Installation. 3 Renewals. 4 Freight	53	63 Piping 1 2 Steam. 3 Water 4 Heaters.	73	83 Lamp Sales.	93 Guarantee Deposits
04 Adv. & Canvas. 1 Advertising. 2 Canvassers. 3 Expenses.	14	24 Dynamo Labor. 1 Brushmen. 2 Regulators	34 Engines. (including labor.)	44 Arc Lamps. 1 Trimming 2 Inspecting 3 Changing 4 Carbons	54 Arc Lamps. (repairs) 1 Labor 2 3 Globes. 0 Misc.	64 Engines	74 Arc Lights. 2 City. 3 Commercial.		94 Accrued Expenses
05 Stat. Postage &c 1 Stationery 2 Printing. 3 Postage 4 Telegrams. 5 Telephone.	15 Inspection (Salaries & wages) 1 2 3 New Business. 5 Customers Complaints. 6 Annual Survey 7 8 Underground 9 House Insp.	25 Water &c. 1 Water 2 Boiler Compound	35 Mech. App. (including labor) 1 2 Pumps. 3 Blowers. 4 Hoists 5 Cranes. 6 Belting 7 Motors.	45	55	65 Mech. App. 1 2 Pumps 3 Blowers. 4 Hoists. 5 Cranes 6 Belting. 7 Motors.	75		95 Install. Co.
06 Insurance. 1 Fire 2 Boiler 3 Elevators. 4 Glass. 5 Casualty. 6 Fidelity. 7 Income. 8 Reserve.	16 Inspection Exp.	26 Fuel. 1 Coal. 2 Wood. 3 Oil 4 Gas. 5 Steam 6 Removal Ashes.	36 Dynamos. (including labor)	46	56 Boosters.	66 Dynamos.	76 Boosters.		96 Meter Inspection
07 Legal & Dam. 1 Counsel. 2 Disbursements. 3 Experts. 4 Sureties. 5 Damages. 6 Medical Attend.	17 Engineering (Labor) 1 Engineering & Lab. 2 Map & Record.	27 Lubricants. 1 Oil Engine. 2 " Cylinder. 3 " Machine. 4 " Kerosene. 5 Grease.	37 Elect. App. (including labor) Switchboard. 2 Feeder Cables &c	47	57 Storage Bat. (repairs) 1 Labor 2 Plates. 3 Acid.	67 Elect. App. 1 Switchboard. 2 Feeder Cables &c.	77 Storage Bat.		97 Real Estate
08 Taxes & Assessm'ts 1 City Real. 2 " Pers. 3 State Franchises. 4 U.S. Income. 5 Realty Assessm. 6 Elect. Control	18 Engineering Exp. 2 Laboratory 0 Misc.	28 Waste & Packing. 1 Waste. 2 Packing. 3 Wipers.	38 Station Struct. (including labor) 1 2 3 4 5 6 7 Station Wiring	48 Subway Rent.	58 Street Cond. 1 2 Feeders. 3 Mains 4 Subsidiaries 5 Junction Boxes. 6 Service Con.	68 Station Struct. 1 2 3 4 5 6 Plumbing 7 Station Wiring.	78 Street Cond. 1 2 Feeders 3 Mains. 4 Subsidiaries 5 Junction Box 6 Service Con.		98 Real Estate Repairs.
09 Furniture & Fixtures. 1 Office Furniture. 2 Partitions & Flooring. 3 Vaults & Safes. 4 Office Wiring 5 Telephones 6 Telemeters 7 Steam Heating.	19.	29	39 Station Tools & Imp'ts	49 Exterior Tools & Imp'ts	59 House Instal. 1 2 Service Wiring. 3 Converters. 4 5 Interior Wiring.	69 Furniture & Fixtures. 1 Office Furniture. 2 Partitions & Flooring. 3 Vaults & Safes. 4 Office Wiring 5 Telephones 6 Telemeters 7 Steam Heating.	79 House Instal. 1 2 Service Wiring. 3 Converters. 4 Motors. 5 Interior Wiring.		99 Removal A/c.

CLASSIFIED INDEX OF OPERATING, CONSTRUCTION AND LEDGER ACCOUNTS.

by any similar corporation in the world. The General Offices are located on the 7th and 8th floors of the Duane St. Station, on either side of a two-story central hall, reached at the seventh floor by a Sprague electric elevator from the Duane street entrance. This hall is lighted from above by a huge skylight which at night will ultimately be an illustration of one of the applications of arc lighting. It is separated from the Duane street front and from the north end of the building by fire walls to prevent the spread of possible office fires beyond the place of origin. The Executive offices occupy the space between the south wall and the Duane street front, comprising, on the seventh floor, the private office of the First Vice-President,

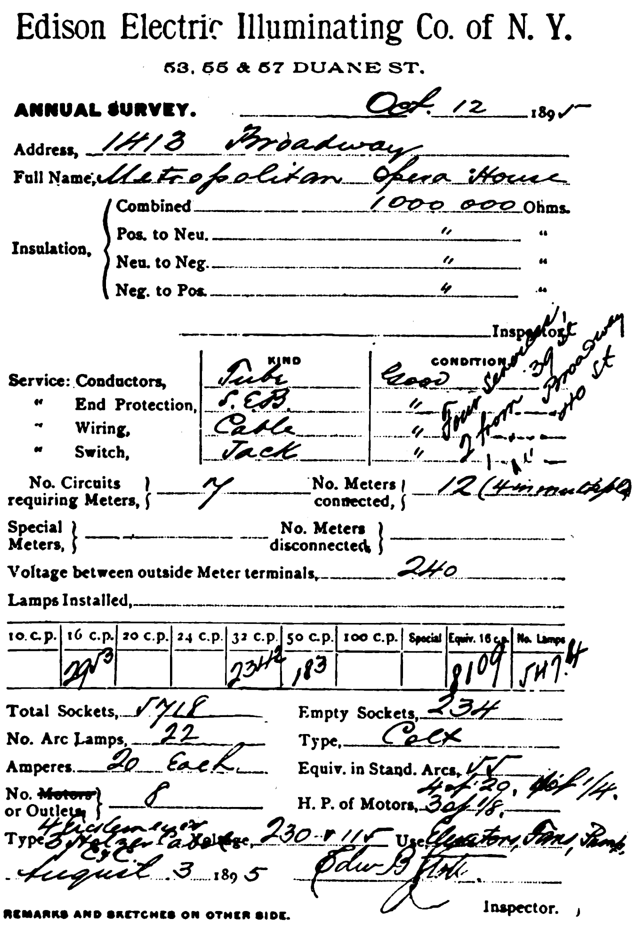
properly directs the customer or visitor. The offices on the right are those of the Fiscal or Accounting departments, those on the left of the Technical departments,—in each case the officials and representatives of the Company with whom the public has to do being found on the first floor, while the clerks and others handling the routine internal work of the Company are on the gallery floor above their respective departments.

The Treasurer and Auditor occupy at the right a room which gives entrance at the one end to the adjoining Cashier's room, where all money is handled and which cannot be entered except through the Treasurer's room, and at the other end to the fireproof vaults, which are

ingeniously placed next to the great chimney-stacks, so that they are kept warm and dry, utilizing a space which would not easily serve for other purposes. On the gallery floor immediately above, reached by a private stairway, is the Book-keepers' room, with its considerable staff, adjoining which is a smaller fireproof vault, above the other vault, for the books of account and for the payment vouchers, which are so kept that any payment in the past two or three years may be verified at a moment's notice.

On the left the offices are occupied successively by the Controller, who has charge of the purchases of supplies, the working orders for the technical departments and the meter bureau; the General Inspector, who has charge of most of the relations with customers; the General Operating Superintendent, who is in general oversight of the stations, and the Installation Superintendent, who is responsible for the underground system and other construction work; these offices being arranged so that those departments having most to do with each other are in contiguity, while all of these departments can be reached from the Executive offices and from one another without going into the public hall.

Above these offices, as indicated, are rooms for the Correspondence Bureau (stenographers and type-writers), the inspectors, the engineering staff, etc. The Meter room,


Edison Electric Illuminating Co. of N. Y.

53, 55 & 57 DUANE ST.

ANNUAL SURVEY. Oct. 12 1895

Address, 1413 Broadway

Full Name, Metropolitan Opera House

Insulation, Combined 1 000 000 Ohms. Pos. to Neu. " " Neu. to Neg. " " Neg. to Pos. " "

Inspector

Service:	KIND	CONDITION
Conductors,	Tube	Good
End Protection,	S. E. B.	"
Wiring,	Cable	"
Switch,	Jack	"

No. Circuits requiring Meters, 7 No. Meters connected, 12

Special Meters, No. Meters disconnected,

Voltage between outside Meter terminals, 240

Lamps Installed,

10 c.p.	16 c.p.	20 c.p.	24 c.p.	32 c.p.	50 c.p.	100 c.p.	Special	Equiv. 16 c.p.	No. Lamps
	2213			2342	183			8109	5474

Total Sockets, 5718 Empty Sockets, 234

No. Arc Lamps, 22 Type, Colt

Amperes, 20 each Equiv. in Stand. Arcs, 55

No. ~~Motors~~ or Outlets, 8 H. P. of Motors,

Type, Voltage, 230 + 115 Use,

August 3 1895

Inspector.

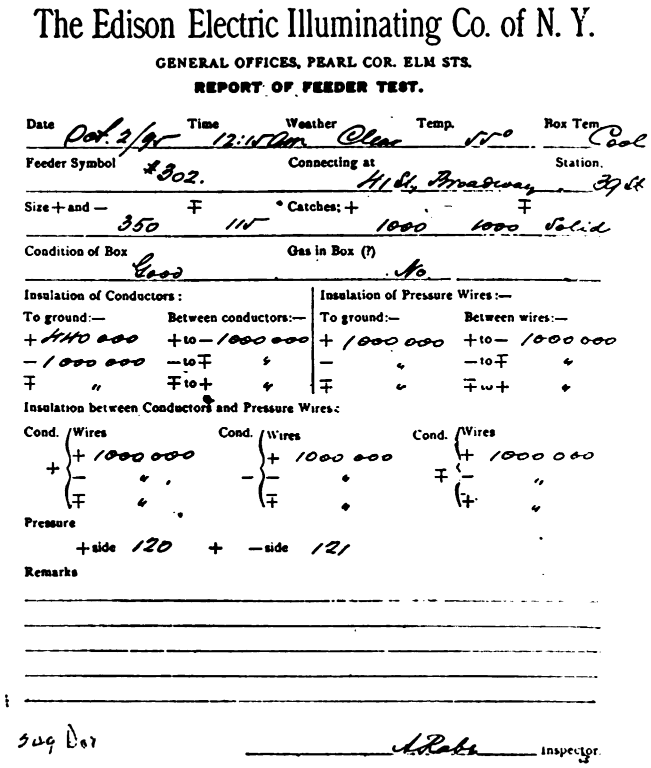
REMARKS AND SKETCHES ON OTHER SIDE.

ANNUAL SURVEY REPORT.

Laboratory, Photometric dark room, etc., occupy the gallery floor beyond the north wall.

All these arrangements are planned to facilitate the utmost economy of time and administration, and the several departments are connected with each other by private telephone, as well as with the other stations by private wire from the General Operating Superintendent's room and with the outer world at large through the telephone exchange.

An interesting and novel feature has been planned for the General Operating Superintendent's room, in the shape of a control board which will give within sight of the General Operating Superintendent at his desk, by means of telemetric instruments, the station load, the pressure on the main 'bus or standard feeder, the steam pressure, the amount of coal as weighed by the weighing chutes, etc.


The Edison Electric Illuminating Co. of N. Y.

GENERAL OFFICES, PEARL COR. ELM STS.

REPORT OF FEEDER TEST.

Date Oct. 2/95 Time 12:15 am Weather Clear Temp. 55° Box Tem. Cool

Feeder Symbol #302. Connecting at 41st & Broadway 39th Station.

Size + and − 350 ∓ 115 Catches: + 1000 − 1000 ∓ Solid

Condition of Box Good Gas in Box (?) No

Insulation of Conductors: To ground:— + 4 440 000 − 1 000 000 ∓ " Between conductors:— + to − 1 000 000 − to ∓ " ∓ to + "

Insulation of Pressure Wires:— To ground:— + 1 000 000 − " ∓ " Between wires:— + to − 1 000 000 − to ∓ " ∓ to + "

Insulation between Conductors and Pressure Wires:

Cond. + Wires + 1 000 000 − " ∓ " Cond. − Wires + 1 000 000 − " ∓ " Cond. ∓ Wires + 1 000 000 − " + "

Pressure + side 120 + − side 121

Remarks

Inspector.

FEEDER TEST REPORT.

A tel-autograph may also be installed by which the other stations may be able to register their data graphically from time to time before the eye of the General Operating Superintendent.

THE STAFF COUNCIL.

One of the interesting features of the Company is the "Staff Council." This body, composed of all the heads of departments, both technical and fiscal, meets every Friday at luncheon under the chairmanship of the Executive head of the Company, and its discussions cover the whole range of the Company's work. The "Staff Council" constitutes, as it were, an advisory board to the Executive, who calls upon it for information to guide him in the management of the Company's affairs.

It includes the Secretary, Mr. Frank Enos, the Treasurer, Mr. Joseph Williams, the Auditor, Mr. H. M. Edwards, and the Controller, Mr. Charles S. Shepard, and the technical staff, viz.: the Assistant General Manager, Mr. John W. Lieb, Jr.; the General Operating Superintendent, Mr. H. J. Smith, with his two District Superintendents, Mr. H. A. Campbell and Mr. W. I. Donshea; the Constructing Engineer, Mr. John Van Vleck; the General Inspector, Mr. Arthur Williams, and the Installation Superintendent, Mr. Henry Stephenson—as also, representing the high-tension companies under Edison control, their General Manager, Mr. Edward A. Leslie.

RELATION TO EMPLOYEES.

The relation of the Company to its employees is also indicative of the care which the management bestows on this important branch of its service. The harmonious relations which exist between them is evidenced by the fact that, with but a single exception, (the case of a

small proportion of employees in its former Wiring Department, who felt bound to take part in a general strike against wiring contractors)—not a single strike or dispute has ever risen between them. Though no regular coöperative system of profit sharing has been established, a beginning has been inaugurated in that direction by the establishment of a system of benefits given to employees at Christmas time. These

LABOR.		MATERIAL DELIVERED.			MATERIAL RETURNED.			EXPENSE.	
DATE.	AMOUNT.	DATE.	SLIP NO.	AMOUNT.	DATE.	SLIP NO.	AMOUNT.	DATE.	AMOUNT.

	ESTIMATED.	ACTUAL.	OVER ESTIMATE.	UNDER ESTIMATE.
TOTAL LABOR,				
" MATERIAL,				
" L. AND M.				
EXPENSE,				
JOB COST,				

Job Order No.

CONTROLLER'S RECORD BLANK.

payments are graded according to length of service and are figured at one per cent. of the yearly wages to employees who have been in the Company's service for one year; two per cent., for those who have served three years, and three per cent., for those who have served five years and over. It has also been the practice for the Executive to issue at New Year's time a circular letter addressed to all the employees, in which the thanks of the Company are conveyed for past meritorious services, and the aims to be striven for and the things to be avoided are pointed out.

The spirit of the administration of the Company is fairly illustrated by sentences in the Holiday letter of 1895–6: "This great corporation is wholly dependent on its good service to the public for its continuing success, and the Edison badge should be an assurance to the public of good sense, good service and good manners. * * * It has been gratifying to receive during the year expressions of appreciation from customers and the public of courtesy

Weekly Report of Operating Department for Week ending Wedne

	ELM ST. STATION.	PRODUCE EX STATION.	FIRST DISTRICT.	12TH ST. STATION.
Ampere Hours Generated.				
Kilowatt Hours Generated.				
Pounds Water, Boiler Meters.				
" " City "				
Tons Coal, last report.				
" " received during week.				
" " on hand at date.				
" " used during week.				
Oil Used, Gallons, Machine.				
" " " Cylinder.				
Pounds Coal, per Kilowatt Hour.				
" Water, " " "				
Labor, number men (engaged producing current)				
" " " (engaged miscellaneous service)				
Total Station Labor.				
" Cost Fuel.				
Cost Fuel, per Kilowatt Hour., Cts.				
" Labor, " " " "				
" Fuel and Labor, per Ampere Hour. ..				

WEEKLY REPORT OF OPERATING DEPARTMENT.

and satisfactory treatment on the part of Edison employees."

CONCLUSION.

The ultimate authority of the Company is vested by its stockholders in a Board of Directors consisting, besides Mr. Edison himself, who has, however, of late years devoted himself chiefly to other lines of electrical development, and President Trask, First Vice-President Bowker and Second Vice-President Peabody, of Messrs. C. H. Coster, Charles E. Crowell, W. E. Glyn, Arthur C. James, D. O. Mills, W. A. Read, F. S. Smithers, of New York, and Mr. A. A. H. Boissevain of Amsterdam and London. Several of these gentlemen have been connected with the Company for many years and to them are largely due the financial support and the direction of large questions of policy which have made the New York Edison Company what it is to-day.

EDUCATIONAL.

ELECTRICITY AT THE YOUNG MEN'S INSTITUTE, NEW YORK

The evening classes at the Young Men's Institute, 222 Bowery, New York, report a large enrollment this season. One of the most popular is the class in Electrical Engineering, under the tutorship of Mr. R. H. Mansfield, Jr., of the Carpenter Enamel Rheostat Co. The enrollment in this class includes workers from all fields of the practical application of electricity. They are taught the fundamental principles of the science and also its latest developments. By means of text books, lectures, and some experiments, a comprehensive view is given of the whole subject.

Other subjects taught are the commercial branches: Arithmetic, Bookkeeping, Shorthand, English Grammar, and technical branches: Carriage Drafting, Steam Engineering, Architectural Drawing, Mechanical Drawing, Freehand Drawing. Some of these require a two and some a three years' course. A new term began Jan. 2nd, 1896. Young men between the ages of 17 and 25 may enroll at any time.

CONGRESSIONAL ORATIONS BY PHONOGRAPH AND TELEPHONE.

Congressman Smith's oration by phonograph is a happy idea. It fills a long-felt want, says the *Philadelphia Ledger*, by demonstrating how a Congressman may address his constituents in a distant city without neglecting his duties at the National Capital. He makes his speech into the receiver of a phonograph, ships it to its destination by express, and there the instrument delivers it by means of a megaphone attachment. Perhaps, in case of emergency, the telephone could be employed for still more direct delivery of Congressional eloquence. It might even be used to enable every constituent to hear his Representative's speeches as they are uttered on the floor of the House, just as it is to convey the strains of orchestral music in Mr. Bellamy's glimpse of the future. Great are the triumphs of modern science.

Society and Club Notes.

NEW YORK STATE ELECTRIC LIGHTING ASSOCIATION.

As the result of the endeavors of a number of public spirited men interested in electric lighting, notably Mr. C. R. Huntley, of Buffalo, ex-president of the National Electric Light Association, a new organization was formed at a meeting held in this city last week representing already some 34 local companies. The new body adopted the title of the New York State Electric Lighting Association, and formulated its constitution, closing its labors by electing the following officers:—C. R. Huntley, of Buffalo, president; M. J. Brayton, of Utica, secretary-treasurer. The executive committee is now being formed, and will be announced later, but the influx of new companies to membership has a little delayed decision on all the details of that nature. The Association is meeting with the warmest support among the local companies of the State, and the indications are that there will be very few not included within its membership.

CONNECTICUT ELECTRIC LIGHTING ASSOCIATION —ANNUAL MEETING.

The annual meeting of the Connecticut Electric Lighting Association was held at the office of the New Haven Electric Company on Dec. 27, the meeting being called to order at 10:30 by the president, James English, of New Haven. The report of the treasurer, A. M. Young of Norwich, was read and accepted. The next business in order was the election of officers for the ensuing year, and resulted as follows: President, James English of New Haven; first vice president, C. H. Merritt of Danbury; second vice president, L. F. Curtiss of New Milford; treasurer, A. M. Young, of Norwich. directors for two years, J. E. Sewell of Waterbury, A. S. Hurlburt of Norwich. E. S. Breed of New Britain and Charles D. Sherman of Meriden were appointed a committee to draft suitable resolutions on the death of the late James A. Hadley, superintendent of the Meriden Electric Light Company, and first vice president of the association.

On the suggestion of Mr. Young it was decided to hold an outing in June at some of the near shore resorts.

A. J. Purington, superintendent of the Stamford Gas and Electric company; Charles D. Sherman, superintendent of the Meriden Electric Light company, and John E. Sewell, general manager of the Waterbury Traction company, were appointed a committee to prepare a joint paper on various matters of interest pertaining to electric lighting, to be read at the June meeting. After adjournment the members accepted President English's invitation to inspect the new office building and testing rooms of the New Haven Electric Company. Lunch was served at Traeger's.

Legal Notes.

SUIT BY CUSHMAN AGAINST THE CUSHMAN TELEPHONE CO.

Sylvanus D. Cushman, inventor of a telephone, and his wife, have brought suit in the Superior Court, Chicago, against the Cushman United Telephone Company for $250,000 damages. The company was organized a year ago, and has a capital stock of $20,000,000—on paper. Cushman surrendered his patents to the company, which was to manufacture telephones, construct lines and establish exchanges. This, he claims, has not been done, and he wants his property again and damages.

FURTHER DELAY IN THE GOVERNMENT TELEPHONE CASE.

At Boston, on Dec. 30, Judge Colt, in the United States Circuit Court, allowed the United States until May 31, 1896, in which to take evidence in rebuttal in the case of the United States *vs.* the American Bell Telephone Company and Alexander Graham Bell, in which the question of fraud in procuring the Bell Company's patent is raised. Judge Colt refused to limit the Government to the question of fraud raised.

Obituary.

ALFRED ELY BEACH.

The death is announced of Mr. A. E. Beach, son of Moses Y. Beach, founder of the *New York Sun*, and himself for the last fifty years active in the proprietorship and management of the *Scientific American*. Mr. Beach was not only a distinguished technical journalist, but an inventor of considerable ability, his pneumatic elevated railway and his hydraulic shield for tunnel work being familiar instances. He was greatly interested in the black race, and after the war founded the Beach Institute at Savannah, Ga., for the education of freedmen. He was 70 years of age.

Personal.

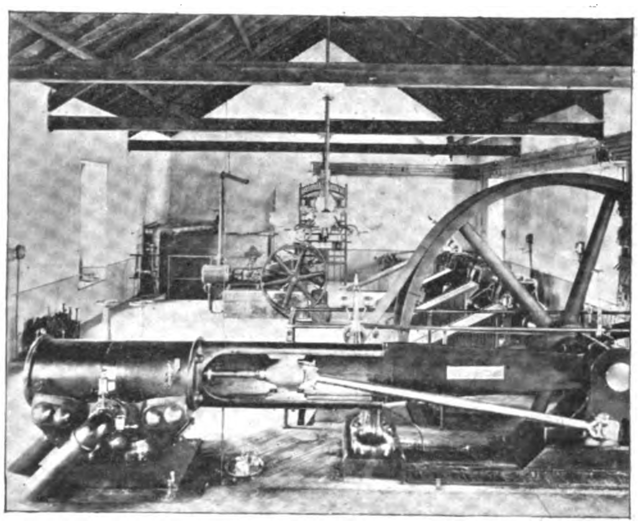
MR. J. H. FINDLAY.

J. H. Findlay.

We present herewith the portrait of Mr. J. H. Findlay, of Ogdensburg, N. Y., who has just been elected to the Executive Committee of the newly organized N. Y. State Electric Lighting Assoication. This gentleman, who is very well known in the lighting field in America, began his career in the gas business about 30 years ago, serving an apprenticeship with his father in Scotland. When he arrived in America the first gas works he took charge of was at Canton, Ohio, where he acted as Supt. and Engr. for 8 years. He went from there to Akron, O., in the same capacity remaining there about 8 years. He rebuilt the gas works at both Canton and Akron. From Akron he went to Ogdensburg 22 years ago and assumed the management of the Ogdensburg Gas Works, which he remodeled and rebuilt.

About 8 years ago, seeing that electricity had come to stay, he added an electric light plant to the gas works, costing over $50,000, erecting a stone building, installing dynamos of 160 arc light capacity, of the Wood type, and a 750 Slattery incandescent using Wheelock and Payne condensing engines for power. During these 8 years he has had excellent success in furnishing electricity, not burning out an armature in that whole period.

About 14 years ago in connection with the above work, Mr. Findlay assumed the management of the Malone Gas Works, and about four years ago consolidated with it a company owning an electric light plant in the town, combining the gas and electric light interests and added a coal business. He also built a very fine new electric plant on the site of the gas works, which cost $25,000, erecting a 2-story brick building, and installed therein Thomson-Houston arc dynamos of 75-light capacity, two 750 Slattery and 500 Thomson-Houston incandescent, with a new



View in Ogdensburg, N. Y. Central Station.

Hamilton-Corliss condensing engine of 300 H. P. Mr. Findlay holds the controlling interest in both the Odensburg and Malone plants.

Mr. Findlay is in the prime of life, active, energetic and enterprising but conservative; and will make an active officer of the new Association of which he is one of the leading spirits.

Mr. B. E. Greene informs us that he has ceased to be editor and publisher of the paper called *Electricity*.

THE
ELECTRICAL ENGINEER
[INCORPORATED]

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CONTENTS.

1—401.

THE present issue of THE ELECTRICAL ENGINEER is No. 401. The first number of this paper appeared January, 1882, when there was no other electrical paper in existence in this country. In entering upon its fourteenth year, the ENGINEER looks back upon a career of useful existence and of steady growth, through periods of public prosperity and adversity, and it believes itself to be to-day in a position of stability and influence that will enable it to do even better work in the future than it has done in the past. As to the actual facts, the ENGINEER would like to point out that while its first monthly issue contained only 16 pages, all told, the present weekly issue contains no fewer than 88 pages. It may also be noted that the issue this week is mainly devoted to a description of the work of the New York Edison Co., the article with supplement running a length of practically 28 pages. This is the fullest and most complete article ever printed on central station work, and the ENGINEER hopes that it may be regarded as an evidence of its determination to excel as the exponent of electrical engineering in America.

THE NEW YORK EDISON CO.

CONVINCED of the importance of correct design and intelligent operation in electric central stations in order to attain commercial success in these days of close competition, this journal has steadily devoted special attention to the description of modern central stations both in the United States and abroad. For some time past foreign activity has compelled us to go far afield at times in order to place before our readers the latest practice, and it is therefore with enhanced pleasure that we now devote the larger portion of this week's issue of the ENGINEER to the description of what has been accomplished in New York City within the last few years in the field of electric central station engineering in low tension continuous current distribution. The work of the New York Edison Company has a special value to the profession in that it, above all others, represents the evolution from the primitive stage of low-pressure, underground distribution. Indeed when one looks back upon the work undertaken fifteen years ago by Mr. Edison, his coadjutors and assistants,—in an art still struggling for its very existence, and to which were added the unknown complications of an underground system,—one is compelled to admire the courage of those pioneers whose work may be said directly to have sealed the destiny of underground current distribution all over the world. Creditable as was the early work of the New York Edison Company, it is not upon that solely that its claim to recognition depends. Its progressive spirit led it to the construction of the 26th and 39th Street stations in New York which in their day were marvels of economy in space for a given power, and are still excellent examples of central station engineering where the same conditions of high cost of real estate obtain. But it is to the new Duane Street and 12th Street stations of the Company that we would draw particular attention, each of which embodies

a number of features of a highly interesting character. The Duane Street station goes to prove that the days of belting in such large central stations are past; but beyond that we note the adoption of quadruple expansion engines, the first of their kind employed for this purpose in this country.

In thus pointing the way towards higher and better steam engine practice, the Company has by no means neglected its electrical equipment which bears the marks of distinct progress both in the adoption,—we might almost say the creation—in the United States of the multipolar type of central station generators and in the later development of regulating apparatus arranged on the Van Vleck edgewise system. The economy in space effected by the former is admirably supplemented by a similar economy with the latter and we have little doubt that the future practice in this respect will be guided by the example set by the New York Edison Co.

As regards the work of the Company, its record of a maximum of 66,800 amperes for a recent day speaks for itself. The load diagram, which we publish on another page, showing the distribution according to time, is particularly instructive. The curve as there shown has a sharp peak, the reason for which will be apparent on considering the large day or motor load on the Company's mains. At this time of the year, the motor load overlaps and is added to the afternoon lighting load and thus serves to bring up the maximum to a point which it would not reach were these different loads confined to particular and distinct periods of the day. This brings up the question of the limit to which it may be desirable to restrict certain types of load during certain parts of the day or season, in order to avoid the installation of steam and generating plant to meet a temporary load of but very short duration. It also emphasizes the fact that to operate economically, a modern central station must be equipped with apparatus able to carry a heavy overload without danger. This consideration is everywhere predominant in the later work of the New York Edison Company, all of whose material is designed with very large factors of safety.

The most recent work of the Company, that embodied in the design of the 12th Street station, will be watched with keen interest on this side of the sea. The employment of the De Laval steam turbine marks another step towards the adoption of improved methods, the success of which, with the results obtained in English central stations before us, can scarcely be a matter of doubt. So also the extension of its storage battery work places the Company in a position to avail itself of all the benefits which that valuable auxiliary has been shown to bestow upon a system of distribution, more particularly the taking care of the temporary high load of short duration referred to above.

With all these facts before us, we believe it is not putting it too strongly to assert that the New York Edison Co. stands second to no similar corporation in the world in everything that goes to make up a successful system of current distribution. That the progress attained has involved the expenditure of large sums before which a less courageous and enterprising management might have quailed, goes without saying; but surely criticism on that score is disarmed when contemplating the magnificent financial results of the Company and its present capacity for enlarged service. No mention of the recent progress of the New York Edison Co. would be complete without a word of praise for its Vice President and Acting Executive, Mr. R. R. Bowker, to whose energy and executive ability the present splendid condition of the Company is largely due.

THE NEW YORK STATE ELECTRIC LIGHTING ASSOCIATION.

WE are glad to announce that a number of the men prominent in electric lighting matters in this State have got together, on the lines suggested not long since by Mr. C. R. Huntley, and have organized the New York State Electric Lighting Association, with excellent officers and a modest programme. It stands to reason that such an Association can do great good in bringing together for mutual support and the exchange of experience and confidence the men who are most deeply interested in the welfare of the electric light industry and investment. We are glad to know that the Association has already received the active support of a remarkably large number of the local companies, and we would earnestly urge those which have not already joined the organization to take immediate steps to that end. In union is strength, and we need hardly point out the good work that such a body can do for the large and important interest it represents. Every local company should consider it a matter of pride to be in active and sympathetic touch with the Association, as its members, and to do all that is possible to make it a weight and power in the community in promoting the welfare of electric lighting. Other State Associations exist, and their success will prove a stimulus and guide to the new body and its officers, who, we are glad to know, have taken up the matter in a broad, public spirited way and are devoting time and thought to the work.

ELECTRICAL PHOTOGRAPHY THROUGH SOLIDS.

A special cable dispatch from London of Jan. 6 says:—The noise of war's alarms should not distract attention from the marvellous triumph of science which is reported from Vienna. It is announced that Prof. Routgen of the Würzburg University has discovered a light which, for the purposes of photography, will penetrate wood, flesh, and most other organic substances. The Professor has succeeded in photographing metal weights which were in a closed wooden case, also a man's hand which shows only the bones, the flesh being invisible. The *Chronicle* correspondent says the discovery is simple. The Professor takes a so-called Crookes pipe, viz.: a vacuum glass pipe with an induction current going through it, and by means of rays which the pipe emits photographs on ordinary photographic plates. In contrast with the ordinary rays of light these rays penetrate organic matter and other opaque substances just as ordinary rays penetrate glass. He has also succeeded in photographing hidden metals with a cloth thrown over the camera. The rays penetrated not only the wooden case containing the metals, but the fabric in front of the negative. The Professor is already using his discovery to photograph broken limbs and bullets in human bodies.

GOV. MORTON ON ELECTRICITY FOR THE ERIE CANAL.

In his message to the New York Legislature, Gov. Morton says: The recent experiments with electric motors for canal boat propulsion made at the western end of the Erie Canal were so successful in character and results as to lead to the belief that when the system is applied to the entire canal it will increase its traffic capacity by at least 35 per cent. Viewing as a whole the many considerations embraced in this subject, it may safely be suggested that it is one of great importance, and not only merits, but will doubtless receive, your most earnest attention.

PRIZE DESIGNS WANTED FOR THE HANDSOMEST POLE.

The Architectural League of New York announces a prize of $50, to be known as the Avery prize, for the best design of an arc light pole. The competition will be open until Feb. 6.

ELECTRIC TRANSPORTATION.

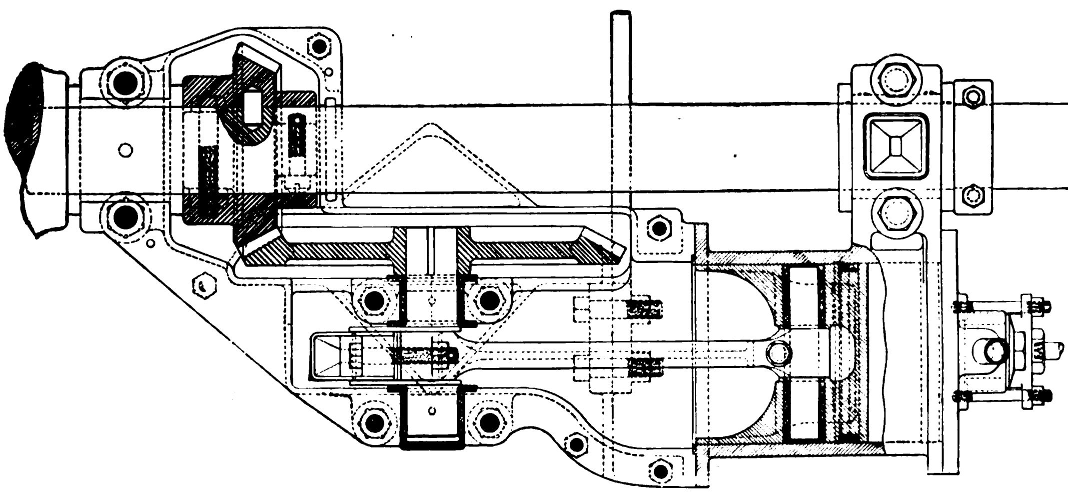
THE NEW STANDARD AIR BRAKE COMPRESSOR.

We illustrate herewith a new and special type of compressor for high speed electric cars now being introduced by the Standard Air Brake Co., whose pioneer and progressive work in this important field of street railway improvement is already so well known.

With regard to the piece of apparatus now presented, it may be remarked, that there are occasions when a company running electric cars at high speed is reluctant to resort to an electrically-driven compressor, on account of cost. In such cases, and where there is a free axle obtainable, the difficulty is met by the use of this geared compressor. Its use will effect a saving in cost over the electrically-driven type.

The construction of the new geared compressor is designed to meet the severe requirements of to-day's practice. The gears are entirely enclosed and they are therefore protected against dirt, slush and water. They are of cast special cut steel ensuring long life. One of the officials of a leading New England road stated recently that their steel cut gears had been running for over two years and showed no appreciable wear. The geared compressor bearings are similar to motor bearings and are provided with ample lubricating facilities.

Another advantage resulting from the use of this geared compressor is the ability to utilize the pony axle on a double truck car, while at the same time the speed of the compressor is brought within a practical limit. By this means the wear and tear is very greatly reduced and it is not necessary for the eccentric to make needless revolutions. For slow speed cars the eccentric encircling the axle answers perfectly. On higher speed cars, however, it is not necessary to have the eccentric throw as often as the increased revolutions make necessary, for it leads to unprofitable wear.



THE NEW STANDARD AIR BRAKE COMPRESSOR.

A noteworthy feature in the geared compressor is the valve arrangement, which renders it possible to unscrew valves without loss of time and to restore them or new ones to place in less than five minutes. It thus becomes unnecessary to remove the car from service in case valves require attention. To admit of increased speed, the valve ports have been enlarged and apparatus designed in various details for this end. The cut does not show the fact that the compressor is meant to be elastically suspended. The supports are flexible, and allow the compressor to meet every condition of swiveling and the upward and downward jolt as well as side play of car body and truck. This means that when the car rides on rough rails, no damage can result to the compressor, as all play is immediately taken up by the new method of suspension. Any jar of the wheels or axles is not imparted to the compressor. In this respect the suspension resembles the latest support of the modern motor.

A special feature of the geared compressor is that there is no chance for the lubricant or oil to escape. This is accomplished by an ingenious arrangement not shown in the cut and the continuous lubrication of crank shaft is also secured. At the same time there is provision made for draining the compressor when it becomes necessary.

This new geared type will be appreciated by managers of high-speed roads who, while realizing the vital need of power brakes, do not feel inclined to pay the increased cost of the electrically driven compressor for the air-brake system. The company is building now, three regular types, viz., an axle-driven compressor for moderate speed cars, a geared type for high speed cars, and an electrically driven type for cars making extraordinary speeds, thus enabling every car in existence to be equipped with an effective air-brake suited to its work.

It is very apparent that the Company's General Manager, Mr. Wessels, is leaving nothing undone to put within the easy reach of every railway manager a thoroughly reliable air-brake. Those who know his executive ability do not doubt his success and cheerfully credit him with highly useful and important pioneer work. The Company is also to be congratulated upon having such an able Superintendent as Mr. Henry P. Merriam, whose well-known mechanical and engineering ability has put him in the front rank in the street railway field.

POWER TRANSMISSION.

TESLA ON ELECTRICITY WITHOUT WIRES.

Mr. Tesla thus writes the New York *Herald* under date Dec. 31:—

In reply to your question as to what discovery would do most to better our condition, in my opinion the demonstration that the earth's electrical charge can be distributed, and thereby electrical waves efficiently transmitted to any distance without the use of cables or wires, would be the most beneficial.

The conveying of motive power from sources such as Niagara in this manner to any place, however remote, would increase many times the productive capacity of mankind. It would bring millions of miserable creatures from the darkness of the coal pits to the light of day. It would cause a kinder feeling to spring up between the weak and the strong, which would lead to a generous adjustment of the evermore difficult questions of labor and capital.

Even if power could not be distributed, the mere transmission of intelligible signals would be of incalculable benefit. Such a realization would do away with the instability of the financial markets, which is the cause of much suffering and misery. It would greatly facilitate the evolution of novel ideas, as well as the prevention of evils. It would increase the safety of travel and give a new impetus to the press and spread of knowledge. The first message transmitted would be the signal to general disarmament and a closer union of nations, and the words of the great German poet, "Seid umschlungen Millionen, diesen Kuss der ganzen Welt," would be deeply felt everywhere.

Our present knowledge is sufficient to fill us with the conviction that the solution of these important problems is not far off. May the new year witness these triumphs.

TO MAKE CHLORATE OF POTASH AT NIAGARA.

Secretary Rankine, of the Niagara Falls Power Company, has announced that his company has made a contract with Walton Ferguson of New York City, under which Mr. Ferguson will erect a factory for the manufacture of chlorate of potash on the lands of the power company and use from 500 to 3,500 H. P. The site selected is to the east of the new calcic carbide plant and covers an acre of ground to start with. The buildings will be put up at once.

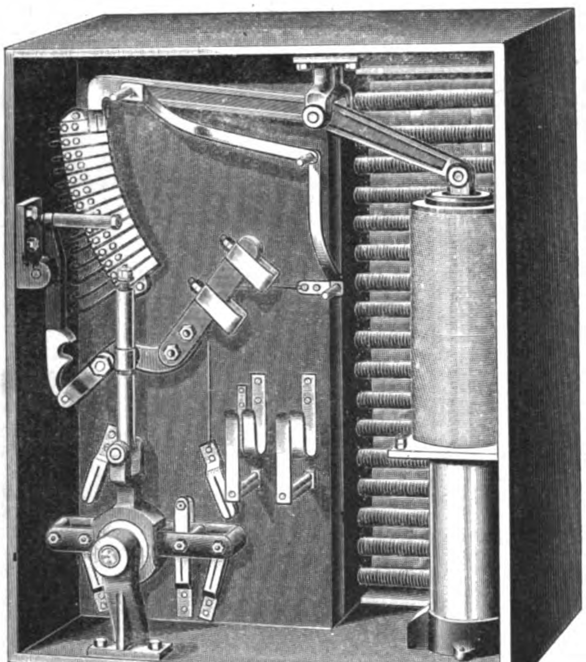
Ricardo Zuloaga, of Caracas, Venezuela, has been at the Falls with Mr. W. B. Wreaks of the Westinghouse Electric and Manufacturing Company to view the power installation there. Mr. Zuloaga is a member of the "Compania Anonima La Electricidad," of Caracas. This company has a project to develop power

from two falls in the El Guaire river, the power to be transmitted to Caracas and used there. One of the falls under consideration has a height of about 120 feet and is expected to give 1,000 H. P., while the other has a fall of 225 feet and will allow of the development of 2,000 H. P. The first fall is only about 10 miles from Caracas, while the second is about 12 miles distant. The lay of the country at the point of the proposed development is such that a surface canal instead of the tunnel method will be used.

THE A. B. SEE ELECTRIC ELEVATOR.

Among those who have devoted their attention to electric elevator work with notable results during the last few years is the A. B. See Manufacturing Co., of 116-120 Front St., Brooklyn, N. Y. The mere coupling of an electric motor to an elevator with a switch to open and close the circuit cannot lead to successful operation. It is obvious that in an electric elevator where the motor is out of sight of the operator, and has to be started, stopped and reversed constantly, often under full load, it is necessary to so arrange a controller that all the current cannot be thrown on the motor suddenly, and so that the switch cannot be left arcing when the elevator is stopped; besides other contingencies that have to be provided for. The controller adapted to fulfill all these requirements used by the A. B. See Manufacturing Co. is shown in the accompanying engraving.

We understand that a suit has been brought against one of the



The A. B. See Electric Elevator Controller.

users of a See elevator on the ground of infringement of a patent which the See Company contends does not contain the slightest hint of the controller used in connection with its elevators. The See Company has, of course, undertaken to defend its customer in the suit. The patent in question was not applied for until December 1884. while Field is well known to have run an electric elevator in 1878, Siemens & Halske in 1881, and Daft, Edison and Sprague had run elevators by electric motors before the patent was applied for. The See Company has sustained its claims of non-infringement by the opinion of such experts as Mr. Edward Weston, Prof. W. A. Anthony and Mr. F. J. Sprague.

SIEMENS-HALSKE POWER TRANSMISSION IN MEXICO.

Manuel Fernandez Leal, Sec. Dep. Fomento, in behalf of the Executive, has entered into a contract with W. Breckman, representing Siemens & Halske, of Chicago, Ill., for the transmission of water power to the city of Mexico from the falls in the municipality of Tenancingo. The concessionaires agree to utilize the hydraulic force produced by the falls of San Simon Atlocomuico and Achayatla for the purpose of generating and transmitting electrical energy to Mexico, the Federal district and neighboring states.

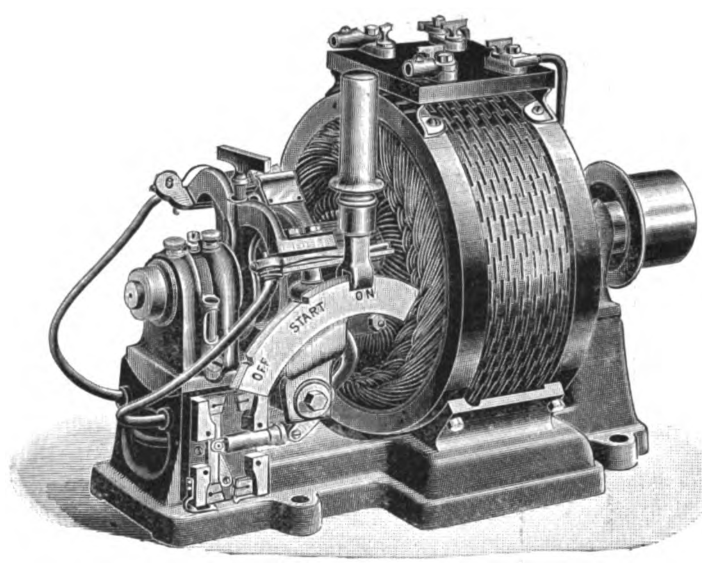
"Enclosed please find draft for $3 to renew my subscription for The Electrical Engineer. I can only say that I am more than pleased in every way with the paper."

Geo. A. Johnston.

THE NEW EMERSON ALTERNATING CURRENT POWER MOTOR.

The Emerson Electric Mfg. Co., St. Louis, Mo., who were pioneers in the manufacture of alternating current fan motors, are now introducing to the trade a line of small alternating current power motors. The ⅛ H. P. size we illustrate in this issue. These motors are non-synchronous, though of practically constant speed, the regulation being within five per cent. between "no load" and the rated capacity of the motor. They are said to possess nearly all the features of excellence of a direct current motor, while being superior in that they, having no commutator in circuit (except while starting), call for no attendance at the brushes. They are protected from lightning by being placed on the secondary side of the circuit, and, being arranged for low voltages, they are protected from the burn-outs due to high potentials and broken wires, which are especially troublesome in 500-volt current motors of small size.

No starting box or other device is required in starting the motor, the stopping and starting being effected by a single lever. This lever moves across a sector (shown in the illustration) with three notches marked respectively, "Off," "Start," and "On." The lever is allowed to remain in the "Start" notch until the motor has attained its normal speed, when it is pushed to "On." In moving to this latter position, the brushes are lifted off the commutator, the external current thus having no connection with the armature winding in this position. The switch and fuse terminals are mounted on the motor itself, the only wiring required with these motors being the introduction of the circuit leads into the terminals. The stock sizes of these motors are made by the



The New Emerson Alternating Current Power Motor.

Emerson Co. for 16,000 and 7,200 alternations per minute, and for 104 volts. Other voltages and frequencies are made to order.

The following are some of the features of merit claimed by the makers for them, the tests having been obtained with ⅛ H. P. motors, and still better results are assured for larger sizes: a starting torque 50% in excess of the running torque; a maximum output of 50% in excess of the rated capacity of the motor; a consumption of energy, running free, of less than 25% of that under full load; an efficiency of from 65% to 80%, according to size and frequency; speed regulation within 5%; a power factor at full load, of 67% on the 130 cycle circuit, and 80% on a 60 cycle circuit, for a ⅛ H. P. machine; and a very slight diminution of torque until the speed has fallen more than 25% below normal, thus enabling the motor to take care of a large temporary overload by virtue of its momentum, and to regain its normal speed afterward. (The inability to do this, is one of the special disadvantages of synchronizing motors.)

These motors are practically noiseless except while starting. They are provided with self-oiling, self-aligning phosphor bronze journals, and a cast steel shaft, the oil boxes being arranged with gauges and cocks, no expense having been spared to make these parts of the motor of the most approved mechanical construction, as indeed they have to be, since the clearance of the armature is a little more than $\frac{1}{100}$ of an inch.

The Emerson Electric Mfg. Co. are putting these out under their usual guarantee, and are finding a ready demand. They have, in preparation, sizes from ¼ to 3 H. P., and are prepared to make prompt shipment on the ½ and 1 H. P. machines of any frequency. Other sizes and a fuller line are promised by them at an early date.

SPRAGUE ELECTRIC ELEVATOR IN THE NEW YORK EDISON STATION.

One of the features of the equipment of the great Duane St. Station of the New York Edison Illuminating Co., described elsewhere in this issue is the Sprague electric elevator which runs from the basement to the offices on the 7th floor.

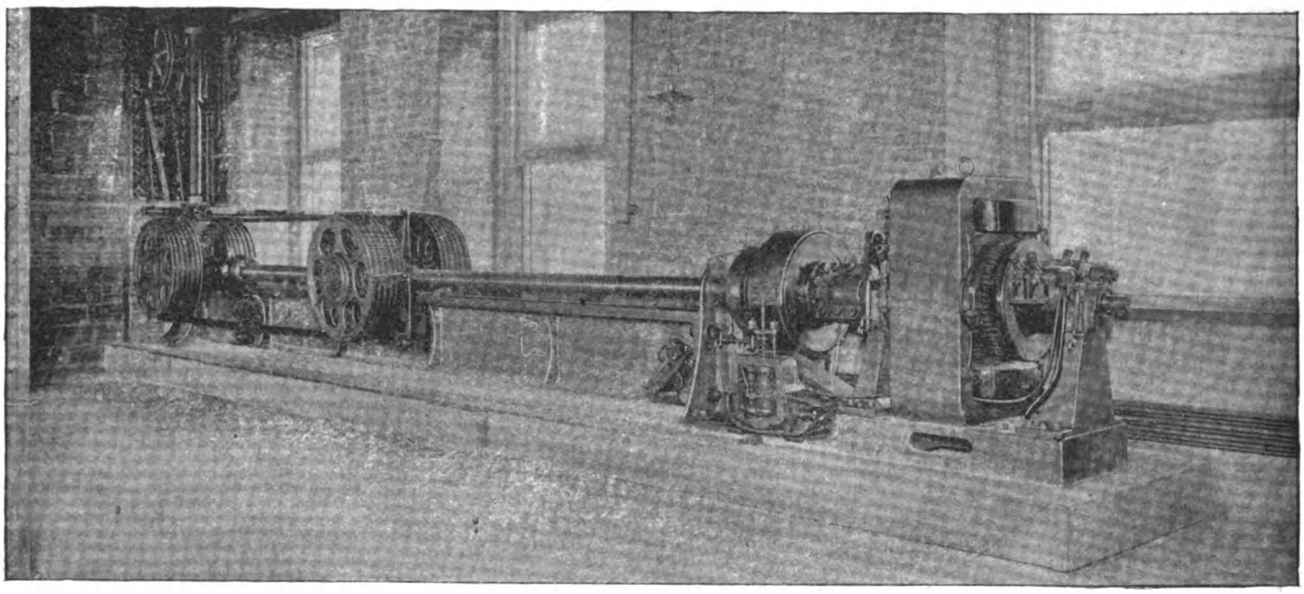
The machine which is illustrated in the accompanying engraving is of the single deck multiple sheave and screw, office building type. It consists of a main bed on which slides a forged steel cross head carrying the travelling sheaves. At one end of the bed is the stand carrying the fixed sheaves, and on the two sets are rove ropes very much as in the horizontal hydraulic tension elevator. The crosshead is moved, in hoisting, by a ball nut of peculiar type operating on a screw directly driven by a motor at the rear end of the machine. The tension on the screw is taken up by ball bearing thrust plates on the back casting, and the machine is locked when at rest by an automatically operating brake.

The elevator is of the gravity type, using power in hoisting, and descending by gravity, when the excess of weight on the car drives the motor as a dynamo. The motor is strongly compounded, and the direction of current is never reversed in the armature or field coils, so that the machine is never demagnetized.

The control is effected by a rheostat operated by a pilot motor, which in turn is controlled by a push-button and an automatic stop lever in the car.

The machine has a capacity of 1,800 pounds, and can drive the car 500 feet a minute. It has all the various automatics, such as upper and lower limits, common to hydraulic apparatus, and, in addition, a centrifugal governor to prevent descending at more than a certain speed, and an automatic control to bring the pilot regulator to a stop position in case the operator lets go his controlling device.

As distinguished from the drum machine, it is the direct rival of the hydraulic elevator for fast service, and is the type now coming into common use through the efforts of the Sprague Company.



SPRAGUE HIGH SPEED ELECTRIC PASSENGER ELEVATOR, DUANE ST. STATION, NEW YORK EDISON CO.

POWER TRANSMISSION AT OGDEN, UTAH.

Rhode Bros., Denver, Colo., are said to have been awarded the contract by the Pioneer Electric Power Co., for the construction of a water power plant. The entire plant will include a dam 450 ft. long, a power house with 10 1,000 H. P. dynamos, six miles of 6-ft. pipe, and is estimated to cost $1,250,000. Work will be begun in the spring. Secy. and Treas., C. K. Bannister, Ogden.

THE CROCKER-WHEELER ELECTRIC CO., Ampere, N. J., have thrown open their factory to inspection on January 15, 16 and 17, one of which days it will be visited by the American Society of Civil Engineers.

JUDGE TOWNSEND, in the U. S. Circuit Court at New Haven, Conn., has heard a motion to reopen the case in which he gave recently a decision in part sustaining and in part voiding the Van Depoele underrunning trolley patent claims.

NEWS AND NOTES.

A MINIATURE MUNICIPAL PLANT FOR PHILADELPHIA.

The Common Council of Philadelphia has virtually provided that a probable balance of $62,000 in the appropriation for street lighting should be set aside to build such a plant.

THE NEW YORK FIRE TELEGRAPHS INVESTIGATION.

With regard to the recent charges made against Mr. J. Elliot Smith, Supt. of New York Fire Telegraphs, that his bureau had been very extravagant, the report now filed by Mr. Callahan as an expert, says:—

"The total amount of cable work done in the years 1888 to 1894, both inclusive, is 463,021 feet of cable laid and connected, 167,661 feet of duct, with pipe, laid and connected, 447 lamp posts, 100 building connections, and the accompanying supply of splicing posts, terminals and flush boxes, service boxes, etc. The average number of conductors per cable is a very small fraction less than nine, and can be called nine. I am prepared to show that the following prices were fair and reasonable: 20 cents per foot for nine-wire cable, laid and connected: 60 cents per foot for ducts built and pipe connected therein; and $35 each for lamp posts placed.

"Applying these prices, we have 463,021 feet of cable laid and connected at 20 cents, $92,604; 167,661 feet of duct and pipe laid and connected at 60 cents, $100,596; 447 lamp posts at $35, $15,645; terminals, flush and splice, and service, $20,000; total, $228,040. The amount expended for the underground cable construction, as shown by the City Auditor's reports during the years under consideration, is $464,000. Deducting the $228,000, as above, leaves $236,000 to be accounted for."

WESTERN NOTES.

THE C. E. WOODS CO. of Chicago, engineers, contractors, etc., in the electrical and other fields have made an assignment. The concern was incorporated last July with a capital stock of $100,000 as a successor to C. E. Woods & Co.

THE WALLACE ELECTRIC CO., 307 Dearborn Street, Chicago, have received an agency from the Adams-Bagnall Co., Cleveland, O., for the sale of their new make of lamps, to which favorable attention has recently been called in the electrical press.

THE ELECTRIC APPLIANCE COMPANY, Chicago, find the new year opening up very satisfactorily for them. Through perseverance and push they have collected a line of first class agencies, which includes bare copper wire, "O. K." weatherproof wire, Packard lamps and converters and Upton arc lamps. In fact a central station man can step into their store (242 Madison St.) and place his entire order for central station equipment, outside of his apparatus. The company have recently been appointed general western sales agents for the Taunton, Mass., Copper Manufacturing Company, one of the oldest and largest manufacturers of copper wire in the country, and are in a position to ship any order for bare copper wire promptly from factory.

TELEPHONY AND TELEGRAPHY.

THE ROUSSEAU "TURN AND PUSH" AUTOMATIC TELEPHONE SWITCH.

ONE of the most recent products of the old established Rousseau Electrical Works, at 810 Mott Ave., New York, is the "turn

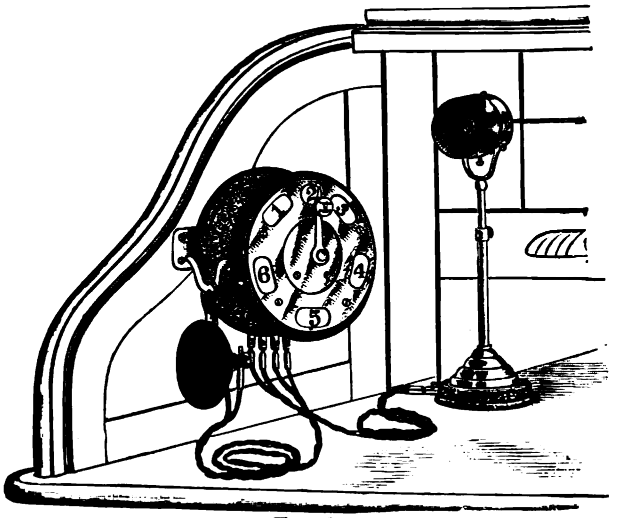


FIG. 2.

and push" automatic telephone switch designed by Mr. D. Rousseau for use in connection with his carbon transmitters. This switch is entirely automatic, dispensing entirely with the central

FIG. 3.

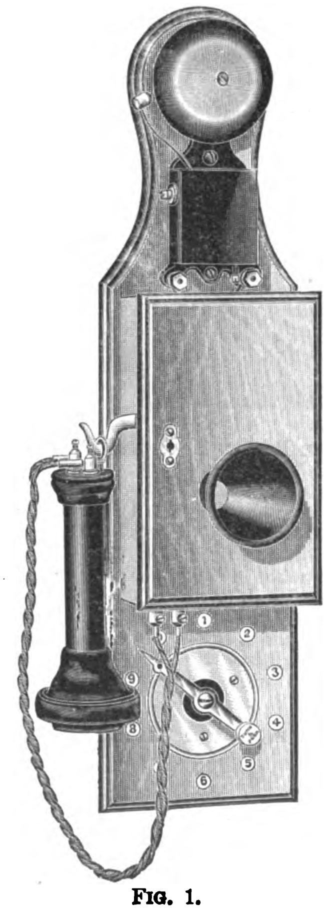


FIG. 1.

station, and permitting one station to talk with any other without interference or interruption.

The engraving, Fig. 1, shows a fancy wall set of this type. When it is desired to call up any station, the pointer on the dial is turned to the number wanted and pressed down, which rings the bell at the station wanted; at the same time a buzzer at the calling end will indicate that the bell is ringing; when it ceases, the caller knows that the other party is ready to talk; he then takes the receiver from the hook, and goes on talking; when through he places the receiver back on the hook, which disconnects all but the caller's own station.

The telephones are arranged to use one set of batteries for call-bells and one set for all the transmitters; but where the lines are long it is advisable to use a separate battery for each transmitter.

The engraving, Fig. 2, shows an automatic switch set, as arranged for desk use, which enables the manager of a business, for instance, to call up anyone in the several departments. It may be of interest to record here that the manager of a large establishment in New York, Messrs. Aitken & Co., employs the Rousseau telephone to dictate his correspondence to a stenographer two floors above.

The Rousseau non-automatic telephone switch set is shown in Fig. 3. With this instrument, when talking is finished, the circuit has to be opened by setting the pointer between any two of the dial numbers; in all other respects the operation is the same as in the automatic switch.

Besides these forms Mr. Rousseau builds a variety of others to meet particular locations and positions, including a telephone exchange battery switchboard for hotels and other similar uses.

A CABLE LINE TO ICELAND.

A GREAT new scheme has been in active progress in London for some time past. It is nothing less than to lay a submarine telegraph line from Shetland, the furthest northern outpost of the British telegraph system in Europe, to Iceland under 500 miles of untraveled sea. The funds necessary for this great undertaking have already been secured, and Great Britain, Denmark, and Iceland will jointly guarantee those who advance the money an interest of 6 per cent. for a number of years. The ultimate success of this undertaking may thus be looked upon as assured.

This news must be hailed with joy by all meteorologists, especially in Great Britain, for whom a daily and regular weather record from a station in the North Atlantic is of inestimable value But England has other interests which have induced her to join in this scheme and bear part of the costs. Her trade with Iceland has been annually growing in volume during the last ten years or still further back, and the time will come when the bulk of the trade of Iceland—which now amounts to somewhat more than $500,000 a year—will be with Liverpool, Newcastle, Glasgow, Dundee, and Hull. It is clear that such a trade will be greatly developed and benefitted by telegraphic communication between the two countries.

There is another aspect of the question, of high importance to a poor country like Iceland. It will bring a stream of tourists into the country, which, though it no doubt will lose some part of its old-world idyllic peace, will be the gainer in the end by increased intercourse with Europe. It is said that the German Emperor has long contemplated a voyage to Iceland in the Hohenzollern, and that it is merely the fact that he could not there be in telegraphic communication with his Ministers which has prevented him from steaming to Ultima Thule, whose sagas he loves and whose grand scenery and natural beauties he is desirous of seeing.

No doubt this telegraph line when finished will open up a new era in the history of Iceland, which, it must be remembered, once upon a time, in the twelfth and thirteenth centuries, took the lead in European literature. Her great past will not return, but there is room for—need for—material progress in the distant island. The telegraph will bring its people within easy reach of European civilization, and they may again recover some of the old glory to which they so often look back with fond regret.

BELL TELEPHONE OUTPUT.

The instrument output of the Bell Telephone Company for the month ending Dec. 20, was normal, although largely in excess of 1894. For the fiscal year the net output has been 94,030, against 17,175 in 1894, 15,980 in 1893 and 39,332 in 1892, so that the year has been a very prosperous one, as far as instruments are concerned. Below are the instrument statistics for the month and the year:

Month Dec. 20.	1894-95.	1893-94.	Increase.
Shipments	14,429	6,472	5,957
Returned	8,073	6,688	1,385
Net output	6,356	1,784	4,572
Fiscal year.			
Shipments	176,060	89,493	86,567
Returned	82,030	72,318	9,712
Net output	94,030	17,175	76,855
Total in use	676,536	582,506	94,030

CONGRESS has been idly discussing the right of the *New York World* to obtain opinions by cable from foreigners on questions affecting American national policy.

Trade Notes and Novelties

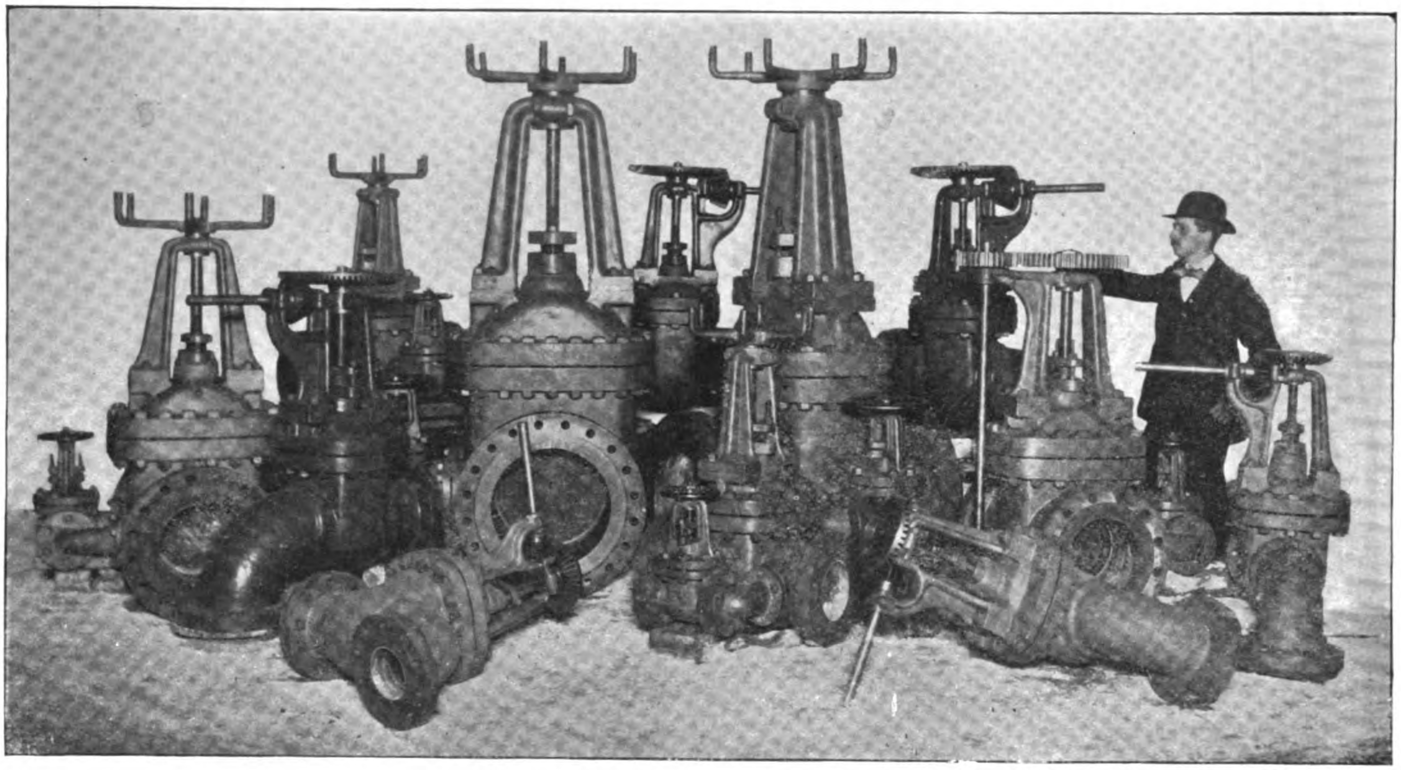
AND MECHANICAL DEPARTMENT.

EATON, COLE & BURNHAM VALVES IN THE EDISON STATIONS, NEW YORK.

In the description of the Edison stations given elsewhere in this issue reference is made to the extreme care exercised by that company in the equipment of its steam plants. This applies as well to the strength of the materials as to their finish and accurate workmanship. The valves which occupy an important place in this department have been carefully looked after, and in the new work of the Edison Co., a number of most important valves were furnished by the Eaton, Cole & Burnham Co., of 258 Broadway, New York, whose works are at Bridgeport, Conn. A group of these valves is shown in the accompanying engravings. The group comprises two 18", one 12", one 10" and two 8" straight way gates, with by-pass, and one 8" and three 6" elbow gates. They are all of the outside screw and yoke pattern, some geared and others provided with spider wheels of the marine type.

In conforming with the requirements of the Edison Company, patterns of hydraulic gates made by the Eaton, Cole & Burnham Company were arranged to suit their specifications. The bodies, bonnets and yokes are all charcoal iron; the seats of phosphor-bronze, and spindles of steel, working on bronze nuts; the discs are cast iron faced with bronze. All joints are scraped and ground, no gaskets being used and the seats are parallel; the gate or disc is double and is straightened by a wedge that strikes a projection in the bottom of the valve expanding the discs firmly against the seats, as they come opposite the pipe opening. The flanges of the 18" valves are 8½" thick exclusive of the ground joint raised faces, and the body is 2⅛" thick; the other valves are proportionately heavy.

All these valves are tested at 400 lbs. hydraulic pressure, and are intended for a working pressure of 250 lbs. The aggregate weight of the group shown, is 26,000 lbs., the 18" valves alone weighing 5,700 lbs. each. They represent probably the finest lot of valves of the kind produced in the United States.



EATON, COLE & BURNHAM VALVES IN THE EDISON STATIONS, NEW YORK.

THE PENN'A INDUSTRIAL REFORMATORY at Huntingdon, Pa., are increasing their electric light plant. They have purchased two 175 H. P. Ball engines built by the Ball Engine Co., Erie, Pa., for the operation of the plant. The Minersville Electric Light Co., Minersville, Pa., are making a number of improvements. They are at present installing a 225 H. P. Erie Ball engine.

THE BARRIETT ARMATURE WINDING CO.

This is the name of a new company just begun operations under the guidance of Mr. S. L. Barriett, whose sole object it is to repair armatures. By concentrating its energies on this business alone, the company believes it will be able to carry on its chosen work to the satisfaction of its customers. None but winders expert in the winding of the various types and makes of armatures will be employed, who will be under the personal supervision of Mr. Barriett, whose long experience in dynamo work is a guarantee of careful workmanship. The company is located at 78 and 80 Cortlandt St., New York.

BAECHTOLD & PARKER ELECTRIC CO.

THE Baechtold & Parker Electric Co., 79 Washington St., Brooklyn, N. Y., are manufacturing a complete line of supplies for all sizes and kinds of American dynamos and lamps, and carry on hand a large assortment of armatures, commutators, brass bearings, brushes, lamps, lamp parts, etc. Their plant has been equipped with special machinery and tools which enable them to fill orders quickly. The Company have a thorough knowledge of, and are especially familiar with. all features and details of the American and Wood arc systems, Mr. Baechtold having had ten years' practical experience with the American Electric Manufacturing Co., New American Electrical Arc Light Co., Standard American Electrical Co., Fort Wayne Electric Co., and Charles J. Bogue. They are also prepared to repair apparatus, rewind armatures, refill commutators, etc., and their facilities are such as to enable them to do first-class work, in short time, at prices consistent with good work, which is guaranteed against faulty workmanship and material.

THE BARNARD WATER COOLING TOWER IN THE TWELFTH ST. NEW YORK EDISON STATION.

One of the features of the new 12th St. Station of the N. Y. Edison Co., is the Barnard water cooling tower used for cooling condensing water. The inventor is Mr. G. A. Barnard and the apparatus was erected by the Wheeler Condenser and Engineering Co., of this city. An illustration of the tower will be found in their advertisement in this issuè, and a detailed description of the apparatus will appear in our issue of Jan. 15.

BOSTON, MASS.—The Lord Electric Co., has been formed with a capital stock of $15,000, to manufacture electric appliances, etc.; Pres., Fred W. Lord; Treas., Thomas P. Curtis, of Boston.

NEW YEAR FESTIVITIES.

To celebrate the close of the old year and the beginning of the new, A. K. Warren & Co. gave their customary New Year's Eve dinner to the employés of the firm,—a practice that has now grown into settled habit with the prosperous young concern. Thee vening at the Maison Francaise passed off very happily and successfully, the dinner being followed by speeches, etc., until 1896 showed above the horizon.

The India Rubber & Gutta Percha Insulating Co. held a reception during the afternoon and evening of the 31st at its downtown headquarters, 15 Cortlandt street. Guests were welcomed by Dr. Habirshaw and by Messrs. Godfrey, Harrington and Olson. The offices were thronged by a goodnatured gathering of wellknown electrical people, and the attendant ambulances were kept waiting a long time.

"Here's Luck" was the brief and characteristic salutation for 1896 sent out by Mr. Charles D. Shain to all who did not drop in to see him and shake hands.

THE GENERAL ELECTRIC TELLTALE DIAL WATTMETER.

In central stations and railway power stations using Thomson recording wattmeters to measure the total output from each machine, or upon each feeder, the grouping of the dials of all the meters in one place where they could be conveniently read at one time has been frequently urged as advantageous. The General Electric Company, has, therefore brought out a "telltale" dial system. This permits the placing of all the dials upon one panel and the installation of the meters out of ordinary reach, as it is no longer necessary to read them each day.

The necessary wiring from the meters to the panel is simple and inexpensive. The panels can be duplicated and the performance of the meters be read either in the dynamo room or in the Manager's office, or any other necessary place, and the performance of the station be accurately learned at any time. Each row

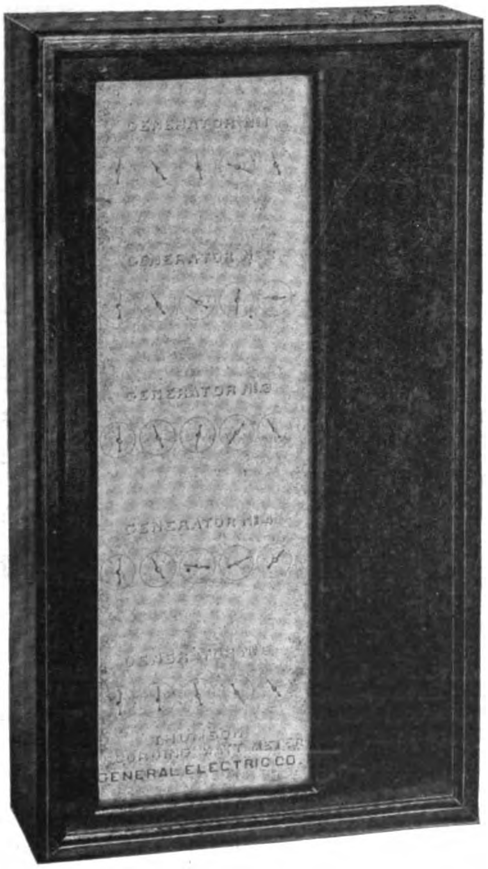


FIG. 1.—G. E. TELL TALE DIAL WATTMETER.

of dials on the panel represents a single generator or feeder, and the recording indicator is actuated every kilowatt hour by a simple make and break device upon the meter measuring its circuit. The dials, one of which is shown in Fig. 1, are several times larger than those on the ordinary meter and they are all direct reading, all constants being eliminated by modifications of the actuating mechanism. It is only necessary in ordering the telltale dial, to state the constant of each meter and the character of the generator, the panel can then be properly lettered.

The introduction of this ingenious telltale system renders the use of a complete system of station output meters possible in many stations hitherto unable to use them on account of the dif-

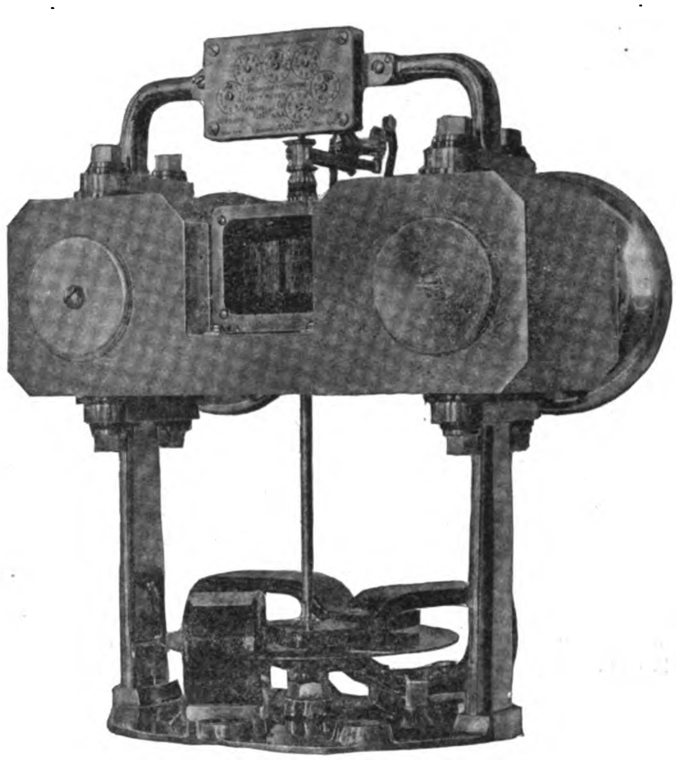


FIG. 2.—G. E. TELL TALE DIAL WATTMETER.

ficulty in installing them, where they can be conveniently and rapidly read.

The station output meters known as "form G," shown in Fig. 2, are constructed upon the same principle as the recording wattmeter, the construction undergoing modification, however, to adapt the instrument to the conditions imposed by extremely heavy loads. They are constructed upon the series principle, the entire current passing through the field, and thus any error and possibility of loss which might result from the use of a high capacity shunt is eliminated.

These meters are adapted for direct application to the switchboard, the studs supporting the meter passing through the board and the bus bars and forming the electrical connection. The conducting parts are of forged copper of the highest conductivity. The three sizes of these instruments, for either 100-volt or 500-volt circuits, are 2,500, 5,000 and 8,000 amperes.

NEW YORK NOTES.

BROOKLYN LIGHTING.—The franchise to the State Electric Light & Power Company has been passed over the Mayor's veto by the Brooklyn Board of Aldermen.

THE TILLMAN ELECTRIC LAMP CO. has been formed with a capital stock of $200,000 to make and deal in electric and other lamps for bicycles, cars, etc. The incorporators are John A. Sullivan, of New York; Jas. Roesler, of Paterson, N. J., and C. J. Henry of New York.

MR. H. H. BROOKS, general manager of the American Circular Loom Co., of Boston and Chicago, was in town recently, and reported that their factory was running day and night to fill orders. Their Chicago office, of which he is in charge, has proved very successful, and flexible conduit, he states, is establishing a good record for itself in the West.

MR. S. F. B. MORSE, of Chicago, of Kerite fame, was in the city this week, and had a chance to see a few of his numerous friends in this city. Mr. Morse is such a generous entertainer in Chicago, that it always affords his Eastern friends pleasure to get an opportunity of reciprocating in some measure, and at least of welcoming him to this city.

THE ALEXANDER SMITH & SONS CARPET CO., of Yonkers, N. Y., have placed the contract for their new dye house building with the Berlin Iron Bridge Co., of East Berlin, Conn. The building is 60 ft. wide and 172 ft. long, the steel roof trusses being arranged to carry cars on the lower chord for moving material about the building.

THE GOUBERT HEATERS AND STRATTON SEPARATORS IN THE NEW YORK EDISON STATION.

One of the most important auxiliaries to a modern economical steam plant is the feed water heater. The accompanying illustration, Fig. 3, shows the type of feed water heater made by the

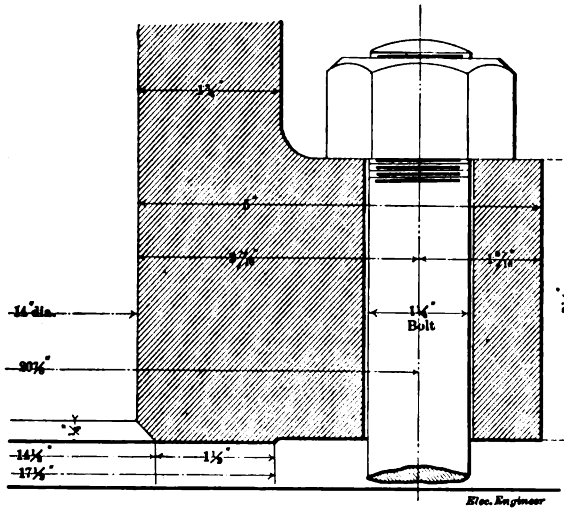


Fig. 1.

Goubert Manufacturing Company of New York, and specially intended for large plants and high pressure. No less than 14,000 horse power of these in units of 2,000 horse power each are

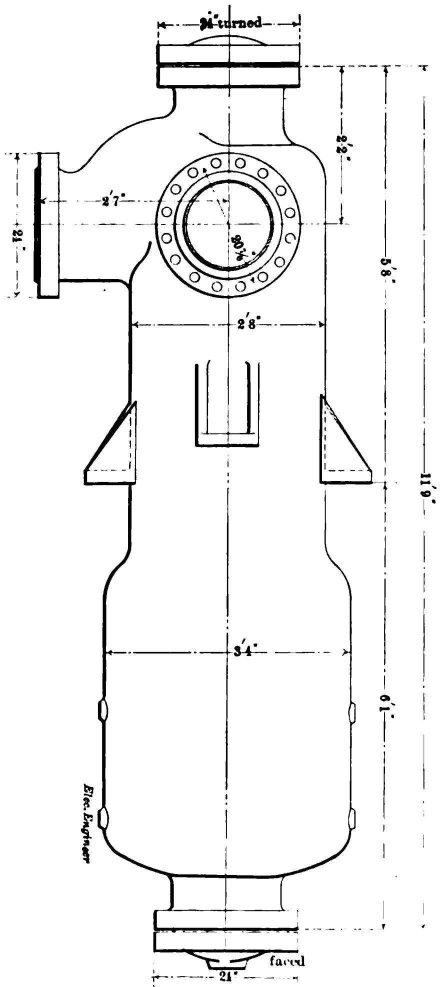


Fig. 2.—Stratton Separator in New York Edison Station.

in use in the various plants of the Edison Electric Illuminating Company of New York, as described elsewhere in this issue.

The Goubert Manufacturing Company has made a specialty of high pressure wosk, and their water-tube feed water heater, as well as the Stratton separator, which is also manufactured by this Company, have been adopted in most of the large electric light and power plants throughout this country.

The Stratton separator, illustrated in Fig. 2, is one of four in use at the Duane Street station and was built to conform to the extremely strong piping system in that plant, as evidenced by the

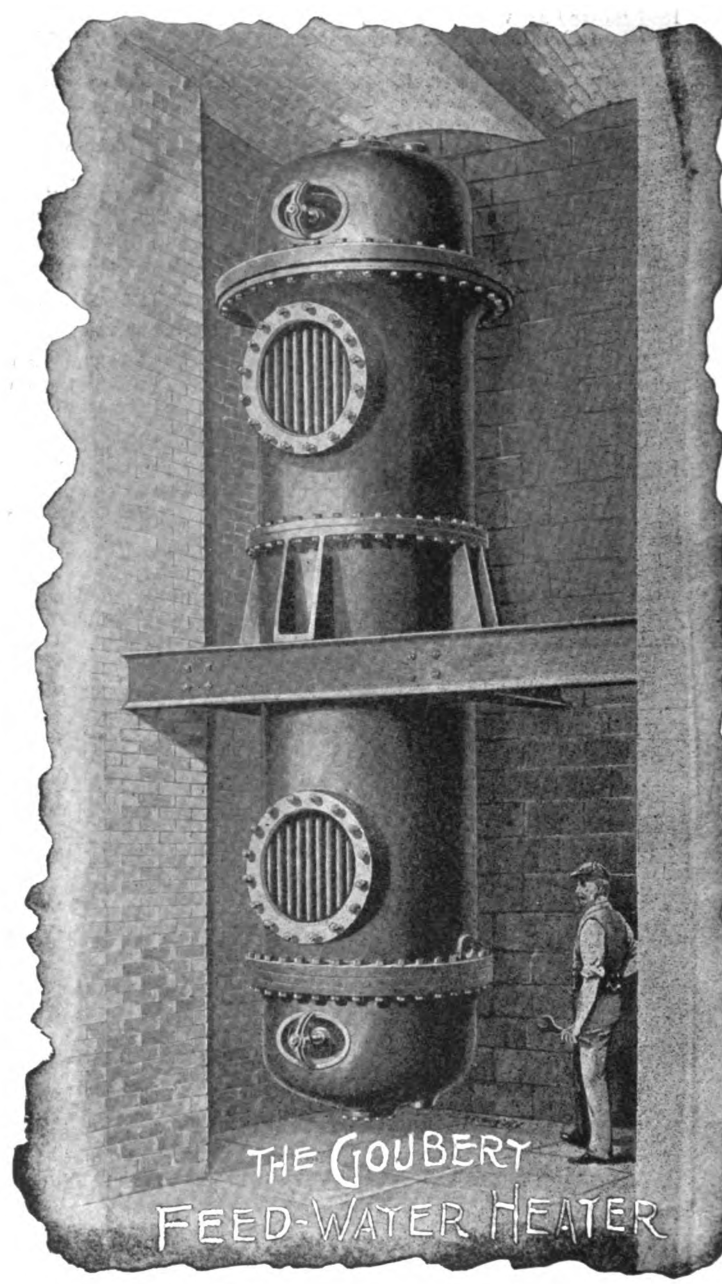


Fig. 3.

sectional view, Fig. 1, which shows one of the flanges, which are 8½" thick. Each separator, which weighs 15,000 lbs., is made of cold blast charcoal iron and was subjected to a test pressure of 500 lbs. per square inch.

WESTERN NOTES.

Dr. H. A. Everett, who since the electrification of the Toronto, Ont., street railway system has been vice-president and managing director, has resigned, in order to concentrate himself on his work for a new trolley system, with cheap fares, in Cleveland.

Stockton, Cal.—The Utica Mine at Angels has suffered so much from scarcity of the local water supply for power, at different seasons, that it is about to begin work on a plant that will be one of the largest electric mining installations in California.

St. Louis, Mo.—Articles of the National Automatic Car Fender Company have been filed in the Recorder of Deeds office. The capital is $125,000, divided into 5,000 shares at $25 each. Charles H. Hofmeister, Jesse A. Graham, Jesse A. Graham, trustee, and D. P. Shields, trustee, each hold 1,000 shares and Henry Moser and D. P. Shields each hold 500 shares.

THE REESE RE-INFORCED COPPER PIPE FOR HIGH PRESSURES.

MODERN electric central station work is approaching more and more to marine practice; this refers not only to the adoption of vertical compound engines direct connected to the generators but to other details, such as the increase in steam pressure and the adoption of devices made necessary in consequence. For connecting the engines with the main steam lines, the best practice now requires the use of copper pipe, but in order to retain its flexibility and still maintain its proper strength some re-inforcing device is required.

Among those who have devoted special attention to this class of work are Messrs. Thomas Reese, Jr., & Co., of 15 to 25 Whitehall St., New York. This firm furnished all the spiral copper banded pipe used in the 26th, 39th and Elm Street stations of the New York Edison Co., and to which reference is made in the article descriptive of these stations, appearing elsewhere in this issue.

The method of constructing this pipe will be understood by an inspection of the accompanying engraving, Fig. 1, which shows a piece of such a pipe in perspective, while in Fig. 2 is shown a section of a 16-inch main used in the Edison Station. As will be seen it consists of a pipe of No. 00000 B. W. G. gauge, around which is wound spirally a band of copper 2" x ½" in section, and to insure uniformity of strain transmission, the spiral band is brazed to the copper pipe.

A special device is employed for making the joint. For this purpose the end of the main pipe carries a heavy copper angle flanged out of solid plate. Seated on this flange is a loose steel ring rolled from a solid forging, in the same manner that locomotive tires are made. This steel ring is drilled for the insertion of bolts for tightening the joint which is made between the copper flanges.

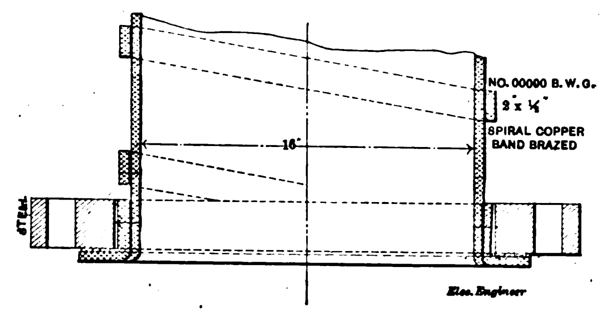


FIG. 1.

Messrs. Thomas Reese, Jr., & Co., who are general mechanical engineers and contractors, also furnished the exhaust pipe and the main smoke flue in the Duane Street Edison station. The former is 32 inches in diameter, and made of $\frac{5}{16}$-inch steel with copper angles and loose steel rings similar to those of the high pressure steam pipe described above.

The main smoke flue is built of ½ inch steel plate, and is so arranged that the air circulates around it and absorbs heat before entering the furnaces under the boilers.

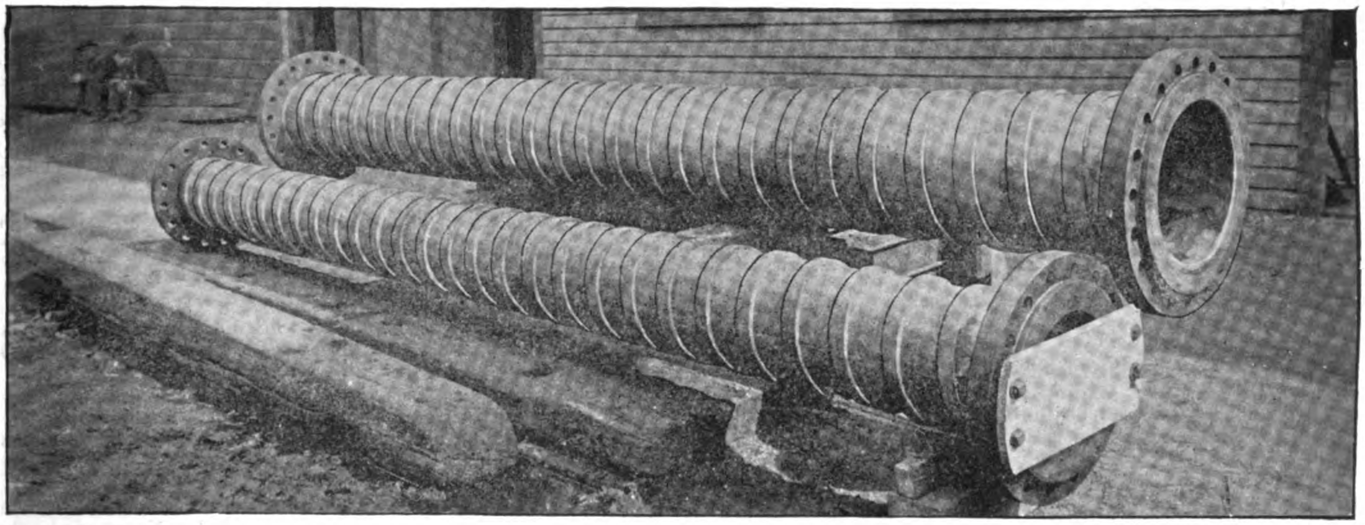


FIG. 2.—THE REESE RE-INFORCED COPPER PIPE FOR HIGH PRESSURES.

LETTERS TO THE EDITOR.

THE CHOICE OF THE TOWN.

The town of Camden, Me., after being in darkness for eighteen months, was again brilliantly illuminated on the ninth of December, much to the delight of the citizens, the ladies being especially jubilant. Manager Hawken of the Knox Gas and Electric Co. has rebuilt the whole line and put in 23 No. 31 Brush double arc lamps, these being the choice of the town.

THOMAS HAWKEN, Mgr.

ROCKLAND, ME.

ASBESTOS AS A HEAT INSULATOR.

WE have received from the McConnell Asbestos Company, Limited, of Pittsburgh, Pa., a pamphlet on "Heat Insulation," read by Mr. John A. McConnell, before the Engineers' Society of Western Pennsylvania. The paper is supplemented by some valuable notes on asbestos, in which the source and purposes of that important heat insulator are described. While asbestos is found in small deposits in almost all parts of the world, its occurrence in commercial quantities is exceedingly rare, the bulk of the entire world's supply being at present mined in the Province of Quebec, Canada, from a little strip of land 3 or 4 miles long, and perhaps a mile wide, or rather from two small patches, one at either end of the strip. There are a few outside mines in Quebec, some of them 30 or 40 miles from the principal deposits, but the output from them is comparatively small. Mr. McConnell, who has travelled nearly all over the United States for the purpose of investigating possible sources of asbestos supply, says he has seen in Wyoming as abundant deposits as in any of the Canadian mines. Lack of transportation is one great obstacle in the way of developing these deposits. There is at present only one railroad near them. But Mr. McConnell looks forward to the time when the United States will be able to fill a large proportion of its own demands in the asbestos trade.

THE BERLIN IRON BRIDGE CO., of East Berlin, Conn., have just completed for the H. W. Johns Mfg. Co., at Brooklyn, N. Y., a new dryer house, which is built entirely of steel.

THE E. T. BURROWES CO., of Portland, Me., are trying to dispose of the 5000 H. P. water privilege of the Saco River at Bonny Eagle, Me., only 17 miles west of Portland and within easy reach of five separate cities.

THE BOSTON ELECTRIC INSULATED POLE COMPANY has been organized at Portland, Me., for the purpose of manufacturing, doing business in and erecting insulated poles upon which wires may be strung, with $100,000 capital stock of which nothing is paid in. The officers are: President, Edward E. Drew, of Boston, Mass.; treasurer, George E. Macgowan, of Portland.

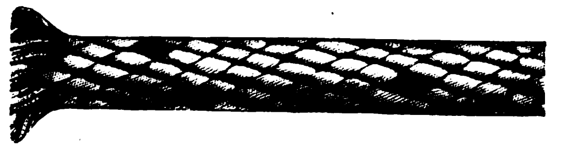
SPRINGFIELD, MASS.—The United Electric Light Co. of Springfield having petitioned for permission to make a bond issue of $200,000, the Massachusetts Board of Gas and Electric Light Commissioners have denied the petition. The Company proposed to acquire 1200 shares of the Indian Orchard Co., which has a broad manufacturing charter and the Commission holds that such an investment would involve new hazards of serious nature, alike to the shareholders and the public.

SAMSON SOLID BRAIDED CORD.

SAMSON braided cord has now become the recognized standard device for the suspension of arc lamps, and it is no less in demand for street car trolley cord and armor cord for covering magnets of dynamos. The size in greatest demand for hanging arc lamps is No. 12 ($\frac{3}{8}$ inch diameter); for trolley cord, No. 8 ($\frac{1}{4}$ inch dia.), No. 9 ($\frac{9}{32}$ inch dia.) or No. 10 ($\frac{5}{16}$ inch dia.); for armor cord, No. 4 or No. $4\frac{1}{2}$ (about $\frac{1}{8}$ inch dia.).

A special waterproof finish is applied, unless otherwise specified. This increases the durability of the cord considerably, and it is strongly recommended for all outside service.

The cord is made of cotton, linen or Italian hemp. The cotton cord is, however, more commonly used, and is probably quite as durable as either of the others. In order to protect their customers against the substitution of low grade cord, the Samson Cordage Works of Boston have undertaken to provide a dis-



SAMSON SOLID BRAIDED "SPOT" CORD.

tinctive mark which will at all times be indicative of first quality cord. They now furnish, therefore, the "Samson Spot Cord," which is their regular "Samson" Cord marked with a series of colored spots. This device they have adopted as a trade mark; and the cord is, as heretofore, warranted of pure stock, perfect braid and smooth finish.

WESTON GENERAL CO.

The formation of the Weston General Company is announced, with Messrs. Edward Weston, F. C. Matthiessen and Henry E. Niese as incorporators, its object being to develop electrical inventions and devices and manufacture and sell electrical machinery and appliances.

Mr. Edward Weston is well known the world over as a distinguished electrical engineer and inventor, and his return to the general field will be universally welcomed. If his new apparatus is as good as his instruments, the success of the Company is a foregone conclusion. It is rumored, though not confirmed, that the new Company will make everything except railway motors. Mr. Weston expects to have his big new factory ready next September.

ADVERTISERS' HINTS.

THE ELECTRIC APPLIANCE CO. has a word to say about "dividend earners" for 1896.

WARREN WEBSTER & CO. note some of the advantages secured in heating by exhaust steam by the vacuum system.

ANOTHER DYNAMO BRUSH has been placed on the market by H. Alex. Hibbard, who carries a full line of electrical supplies.

H. B. COHO & CO. are doing a large business in Eddy direct-connected generators for isolated plants.

AMMETERS AND WATTMETERS are advertised by the Western Electric Co.

OVER 14,000 H. P. of the Goubert feed-water heaters and the Stratton separators is installed in the various plants of the New York Edison Co.

ROUSSEAU'S AUTOMATIC TURN AND PUSH TELEPHONES dispense entirely with a central station. They are specially adapted to a large variety of uses.

THE E. P. GLEASON MFG. CO. will send on request one of their "lightning bug" cut-outs which they hold to be the handiest and smallest fixture and bracket "bug" ever made.

THE EATON, COLE & BURNHAM CO. describe one of their improved pipe threading machines for belt power or engine attachment. They also manufacture a large variety of valves and fittings.

A TABLE OF REVOLUTIONS of slow and moderate speed generators for light and power appears in the announcement of the General Electric Co. in this issue.

THE CALCULAGRAPH CO. continue to advertise their instrument for keeping tab, of which they say "It saves labor and makes no clerical errors."

ELECTRIC RAILWAY MEN will find a great deal of interest to them in the several "ads" of the Standard Air-Brake Co. appearing this week. Under such headings as "Ancient History," "The Handwriting on the Wall" and "How to Win Some Dollars". They discuss questions of to-day in a style quite refreshing and worthy of initiation by other advertisers.

THE C & C ELECTRIC CO. state there are more of their motors installed on the circuits of the Edison Electric Illtg. Co., of New York City, than of any other make.

THE GREGER NOISELESS MANHOLE COVER CO.'s card in this issue shows another style of their covers. Possessing so many decided improvements their universal adoption is assured.

THE FARR TELEPHONE AND CONSTRUCTION SUPPLY CO. show several of their instruments in this number, giving their prices and offering their illustrated catalogue on application.

THE BAECHTOLD & PARKER ELECTRIC CO., manufacturers of the "American" arc dynamos conduct also a repair department and guarantee against faulty workmanship and material.

JAMES G. BIDDLE announces that his "Catalogue X" is the most complete, concise and convenient price list of Weston instruments ever distributed.

NO CENTRAL STATION IS COMPLETE unless installed with "Kerite" wires, according to W. R. Brixey. The demand for them is as large as usual.

THE NEW YORK EDISON CO. have tested and are constantly using the "Electra" high grade Nuernberg carbons, imported by Hugo Reisinger, New York, who carries all sizes, cored and solid in stock.

THE MICA INSULATOR CO. publish a testimonial letter from the Fort Wayne Electric Corporation regarding the very satisfactory results obtained from using "Micanite" for insulating purposes in dynamo and motor construction.

"A STATEMENT OF FACTS."—Under this title the A. B. See Mfg. Co. gives a brief history of the suits brought against it for alleged but indefinite infringement of another company's patents and also illustrate some of their apparatus.

THE STAR ARC LAMP embodies all the latest improvements, is the claim made for it by the Auerbach-Woolverton Electric Co., who guarantee perfect satisfaction to each customer. Their catalogue for 1896 is now ready.

THE INTERIOR CONDUIT & INSULATION CO. calls attention to the completeness of its output for the generation, distribution and utilization of current. Selling on its merits the apparatus is rightly more popular than ever.

THE DICKINSON ELECTRIC SUPPLY CO. are introducing an advertising lamp. Each lamp is a single letter, thus greatly simplifying the construction of a sign, making the cost low and permitting a change in the reading without any trouble.

R. B. COREY'S ABILITY to fill orders for arc lamps and carbons is continually increasing. Lamps in every style and for every kind of service and the renowned Schuyler Nurnberg carbons partially constitute the stock he has to draw from.

THE REESE REINFORCED COPPER PIPE, with hammered steel flange rings is in use in the Edison Company's station in this city. Thomas Reese, Jr. & Co. also make special pipe, valves and fittings for high pressure steam of cast iron and steel.

THE SPRAGUE ELECTRIC ELEVATOR CO. publish a list of buildings in which their elevators are now in service. The length of the list is a good proof of their excellent work. They build them for any speed and capacity.

"WHY NOT HAVE THE BEST" is the question asked by the India Rubber and Gutta Percha Insulating Co., who also say "It would surprise you to know how many miles of our wire carries current to lamps and motors from the Edison Stations in this city."

THE BRISTOL COMPANY catalogues over one hundred different varieties of recording instruments for pressure, temperature and electricity. Parties interested are invited to write for prices and discounts, and to order an instrument for a month's trial with privilege to return if not satisfactory.

WATER WHEELS of from three feet to two thousand feet head for lighting and power plants are manufactured by the Jas. Leffel & Co., who are now constructing four 2,000 H. P. wheels for the Niagara Falls Hydraulic Power & Mfg. Co. Their thirty-three years of business in this line amply qualify them to meet all requirements.

THE NEW YORK ELECTRIC EQUIPMENT CO. assert they have connected more lights, motors, arc lamps, etc., to the mains of the Edison Electric Illtg. Co. of this city, than has any other company. With every facility for doing first class work they should be and are able to give entire satisfaction in all they undertake.

A MAGNIFICENT ENGINE IS SHOWN in the advertisement of the Southwark Foundry and Machine Co., for direct connected service in the station of the Edison Elec. Illtg. Co. of New York. These engines have been found especially efficient for direct coupling and they have installed them in several of the largest stations in the U. S.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Financial, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

Vol. XXI. JANUARY 15, 1896. No. 402.

ELECTRIC LIGHTING.

THE MARKS VENTILATED ENCLOSED ARC.

THE shortening of the arc for a given drop of potential due to surrounding the arc by an inclosing medium and excluding oxygen, has made it necessary in the commercial operation of inclosed arcs to employ a higher drop per inclosed arc than would be necessary for open-air arcs, for a certain length of arc is required in order to produce a steady light, and in the case of the inclosed arc a greater potential difference is necessary to secure this length of arc than in the case of the open-air arc. This follows naturally from the increased resistance of the inclosed arc. If the attempt be made to operate the inclosed arc at as low-potential drops as open-air arcs, unsteadiness of the light results. Because of the flattening of the carbon points due to being consumed in the absence of an oxidizing agent the light is largely obscured and the illumination effective only in a small zone. Moreover, if operated at as low a potential drop as an open-air arc, the negative electrode invariably builds and a mushroom-shaped formation results. This formation consists largely of graphitic carbon. The nib thus formed breaks off eventually at its neck and flickering and unsteadiness of the light results.

To avoid these difficulties Mr. Louis B. Marks, of New York, whose work in this field is well known, has designed an envelope in which a limited circulation of air takes place, and which is illustrated in the accompanying engraving.

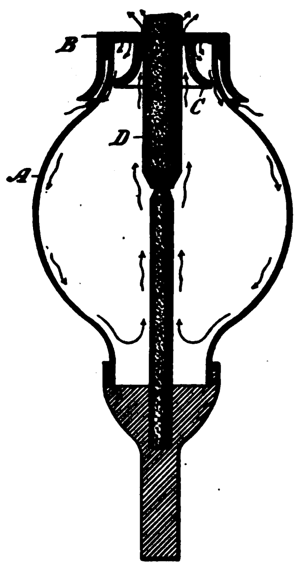
The envelope A is provided at the top with a loosely-fitting cap B touching the cylinder only at four projections in the centre of which is a circular or conical tube C, through which the positive electrode D is fed to the arc. The negative electrode, by reason of its slower rate of consumption, may be smaller in diameter than the positive. The outer portion of the cap is enlarged into a bell-shaped flange, the rim of which is brought closely adjacent to the exterior wall of the envelope. Thus there is provided a narrow annular passage for the outside air into the envelope, one of the walls of this passage being formed by the envelope, which, by reason of its high temperature, heats the entering air in transit into the envelope. The tubular opening through which the electrode feeds is made slightly conical in shape, the enlargement at the top being only a little greater than the diameter of the electrode, so as to permit a free feed of the latter and to afford an obstructed egress for gases from the envelope.

The lower part of the tube is flanged away from the electrode as shown, this form serving as a deflector for the upward currents around the positive carbon, the flange at the same time forming a deflecting-wall for the ingoing air and directing the latter outwardly toward the walls of the envelope. The tendency with this arrangement is for all egress to take place by way of the central tubular opening and all ingress by way of the bell-shaped chamber.

The arrangement of the cap as above described deflects the ingoing air into the downwardly-moving portion of the convection current, where it is intimately mixed with the gases already formed in the envelope and raised in temperature, so that it is intensely hot by the time it reaches the arc.

A highly important result which follows from the distribution of air-currents as described is that the resistance of the arc-stream, instead of being considerably increased, as is the case with other inclosed arcs, remains practically the same as in an open-air arc. The length of arc for a given drop of potential is therefore practically the same as that of an open-air arc of the same drop of potential.

Because of the flow of convection currents of arc-gases admixed with atmospheric air the electrodes do not burn blunt as in ordinary inclosed arcs, but have much the same shape as points formed in open air. The crater formed in the positive is substantially uniform in curvature, while the apex of the negative is quite pointed and well centered with reference to the crater of the positive. Thus there is practically no obscuration of light as in



MARKS VENTILATED ENCLOSED ARC

the usual inclosed arcs where the electrodes burn to blunt points. The light is steady and efficient at practically as low drop of potential as with open-air arcs.

Lamps with this type of envelope can be run at 45 or 50 volts and the carbons have a life of 50 hours.

FALL RIVER, MASS., LIGHTING COMPANIES TO CONSOLIDATE.

THE Edison Electric Light Company and the Fall River Electric Light Company are to consolidate. The capital of the Fall River company, which was recently increased, is $200,000. It has a valuable contract with the city for lighting the streets. The Edison's capital is $150,000. It operates the incandescent lights. Details are not to be made public until legal permission is granted for the union.

THE DETROIT MUNICIPAL ELECTRIC LIGHT PLANT.

BY JAMES I. AYER., EX-PREST. NAT. ELEC. LT. ASSN.

NOTING the recent discussion of the cost of electric lighting in Detroit, I recall the fact that a number of years ago one Whipple, when city clerk of Detroit, at the expense of the city, gathered together a lot of data (which he published in book form, for his own profit), which indicated that arc lights under municipal ownership could be produced for from $30 to $50 per lamp per year. A little later reports from Chicago, derived from about the same experience in operation as from the basis of the statement of the Detroit cost, stated the cost under municipal ownership to be about $50 per lamp per year. As is well known, Whipple's book was ingeniously compiled to tell only a one-sided story and was as unreliable as the author proved to be himself.

As to Chicago, the new Moses who was to lead the taxpayers out of the darkness with the cheap light proved to be a veritable "will o' the wisp" leading them deeper and deeper into the mire of debt from year to year until now the annual cost is more than three times the original figure.

Mr. Dow, with the limited experience of two or three months' operation of the completed plant, with everything brand new, the repairs on most if not all of the station machinery being cared for by the contractors without cost, with all employees doing their best, without the plant being encumbered by the usual accumulation of political barnacles which come in due time, without including any cost for depreciation, for taxes, etc., assumes that the figures derived are the proper ones to put before the public as the cost of producing an arc light, and assumes that with time the cost as shown will not change. Mr. Dow states that the "expensive" and "thorough methods" of maintenance under his "fixed policy" together with the appreciation in value of the real estate will keep up the value of the plant to its original cost so that the item of depreciation should not be considered. It is manifestly absurd to talk about maintaining permanently the value of the first investment without providing a sinking fund for the necessary improvements and repairs. No one believes that a station, no matter how well cared for, that was built ten years ago, still operating the old machinery, has the same value as when it was installed.

The appreciation in value of the ground would have to be something enormous to justify the abandonment of the present site with its expensive foundations, etc. From a recent article[1] published in defence of municipal ownership the following occurs in reference to the lighting plants owned by Chicago, the oldest of which has seen but seven years of service: "Now as a goodly portion of the machinery * * * is no longer looked upon as up to date, that is—suitable, efficient and economical—the factor of depreciation must far exceed the usual allowance. In fact in comparison with some recent installations much of the apparatus owned by the city would bear a strong resemblance to the reported loss that occurred in displacing the cable lines in Philadelphia with electric traction" * * "the machinery at the power station * * represented to the Traction Company an immense amount of money * * hundreds of thusands of dollars * * " and "of all the machinery in the immense plants the engines and boilers are alone valuable above scrap iron." Mr. Dow as a partial explanation for low cost says that service furnished by contractors would have to be extended wherever required whether it was profitable to do so or not, but that he does not intend to take on such service. Such a statement does not require a comment.

A member of the lighting commission states (and an investigation of the figures so indicates) that with 5 per cent. charged for depreciation the present cost is practically at the rate of $100 per year. With this showing now during the first few months of operation what is reasonable to expect as an average cost for the next five years, under municipal management? Mr. Dow, no matter how good his intentions, cannot keep off the political barnacles, any more than he can prevent an increased cost for maintenance in the way of repairs etc., or prevent depreciation.

At present while the new $600,000 plant is barely in operation it is not sufficient to supply the wants of the city, and to meet the additional demands. An ordinance has been introduced which contemplates the expenditure of $150,000 more if the plans are carried out A few years ago, largely on account of improvements in electrical apparatus and steam plants, Detroit was able to effect a radical reduction in the cost of street lighting, under competition between contractors, and since has been enjoying the benefits of lights at very moderate cost. When by reason of proposed extensions the cost of the plant is increased $200,000 or more, and the "expensive lighting" is taken on and the cost of light far exceeds the rates formerly paid by the city, then we shall have another exposition of Chicago's results, viz.: much of the plant out of date and a considerably increased investment necessary to put it in shape to meet the new conditions. Cheap lighting may be possible under municipal control, but it has not been so demonstrated in this country. As has been well said many times before, municipal ownership of lighting plants, after an unprejudiced investigation, only meets with the enthusiastic approval of the ubiquitous politician.

1. *Electrical Engineering*, Vol VI., page 304.

THE CATHODIC RAYS.[1]

BY CH. ED. GUILLAUME.

SINCE we gave an account here of the important work to which the mysterious phenomena of the cathodic rays have given occasion (July, 1894), the attention of physicists has been drawn more than once to their true cause, the partisans of the two theories accumulating since then argument on argument, none of which appears absolutely decisive.

The English opinion, founded on the theory of Mr. Crookes, of a molecular bombardment in a very rarefied gas, defended by such champions as Lord Kelvin, Prof. Fitzgerald and Prof. J. J. Thomson, has recovered ground on the theory of the vibratory origin of the rays which is particularly sustained in Germany. At the base of this latter opinion we find the remarkable labors of Messrs. Goldstein, Autz, Wiedemann and Ebert, and especially those of Mr. Lenard.

We recount the facts. If, in a thoroughly exhausted tube electrical discharges are provoked, glitters (gleams) of a peculiar sort are produced due to these rays propagating themselves in a straight line, and which appear, especially when these rays strike any solid, liquid or gaseous body. Very indistinct in a gas, these gleams become intense on contact with solids, and specially brilliant when the rays fall on certain phosphorescent bodies.

These rays traverse bodies without exception if of less than certain small thickness, and, while their production is intimately bound to a very tenuous state of the matter about the cathode of a Crookes tube, their propagation is effected in any medium whatever. Their presence in the air is obvious several centimetres from the apparatus, after the ray has crossed a metallic septum closing the tube in which they are produced. Starting from the facts put in evidence by Mr. Lenard we were inclined to think the Crookes theory should be abandoned, and in this bias finished our first article.

The errors of the bombardment theory once shown, it seemed relatively easy to explain the phenomenon as a wave motion analogous to that which produces light. Certain bold spirits have dared to invoke longitudinal vibrations of the ether, or radiations of short wave lengths with which certain peculiarities of the rays present striking analogies.[2]

Within a year no one has made a step in this direction whereas several connected facts have impeached the theory of Mr. Crookes in which at any moment an absurdity is liable to appear. We mention here only by way of memorandum an experiment of Mr. J. J. Thomson on the speed of cathodic rays. The eminent Cambridge professor provided himself in order to determine this speed with a mirror turning around an axis parallel to the direction of propagation in the tube, and throwing reflection suc-

1. From *La Nature*, Dec. 21, 1895.

2 This theory has been developed in very ingenious fashion by Mr. Jaumann; but Mr. Poincaré has shown quite recently that the hypotheses of the learned Austrian professor take no account of the rectilinear progress of the rays, nor of their deviation in the magnetic field.

cessively on two screens at the distance of two centimetres. The images reflected by the mirror, and corresponding to the first trace of light produced by the phosphorescence of the screens were in the extension of each other so long as the mirror was quiet, but were distinctly parted when the mirror was rapidly turned.

It may be concluded from this that the propagation of the rays takes place with a finite velocity as is deduced from the displacement of the images. The measures of Prof. Thomson give a speed of 200 kilometres a second, a speed which he finds justified, on the hypothesis of bombardment, by the efforts the molecule makes in the neighborhood of the cathode as it carries its electric burden.

It should not be forgotten that the calculation of this speed is founded on the measure of a time interval of one-half a millionth of a second, and that, if the retardation of the phosphorescence of the second screen due to the weakening of the ray in its course, marked this limit, the experiment might just as well lead up to very great velocities, that of light in particular. As any hastening of the phosphorescence of the second screen is inadmissible, as is also any gross error toward the lessening of the time period, Prof. Thomson's experiment only shows that the speed of the rays is very great, incomparably greater than that of the gaseous molecules according to the kinetic theory. This is not an argument against the ideas of Mr. Crookes, as Prof. Thomson indicates a reason for a very great speed; but this rate of motion, 200 kilometres a second, brings no advantage to the theory of radiations while the rate given is out of agreement with what we know of the rapidity of the movements of transmission of ether perturbations.

It is apropos to note the discussion on the absence of the Doppler-Fizeau phenomenon in cathode rays. If the cathode rays are due to matter in motion, say the partisans of the radiation theory, a displacement of spectral rays should be seen agreeing with that seen in the motion of the stars, not a trace of which phenomenon has yet been seen. Lord Kelvin has well said that if one is limited to speeds less than one kilometre a second, as certain calculations indicate, the phenomenon would be at the limit of sensibility of the actual instruments. But this argument does not hold if the speeds are considerable, and the experiments of Prof. J. J. Thomson permit of no doubt in this aspect of the question.

At the same time the cause does not seem desperate. The gleams which are seen may not be due to matter in motion; one always sees them whenever there is shock, in which case it is the molecule in repose, or slightly displaced by the shock which emits the light; in this case the phenomenon of Doppler disappears from the question and there is no room to invoke it pro or con. It is possible some one will see it any day under particular circumstances. It certainly would not have the intensity which the speed found for the cathode rays assigns to it, and the cause of the divergence would be due to the fact that the speed taken by the particles of matter under the influence of shock would be much less than that of the primitive atoms. There are good reasons for believing this is so.

But can one admit that material particles, even thrown with great speed, can traverse solid bodies below a certain thickness, or metallic films not absolutely opaque, and hold their course indefinitely into space? The thing is difficult, but not without a certain degree of probability.

In an experiment already old, Mr. Arons has shown that a very thin metallic septum placed across a trough containing acidulated water is not charged with gas on its faces, and gives rise to no counter electromotive force, while the current is sensibly weakened if this plate is replaced by a thick one with a hole in it far larger than the sum of the visible pores in the metal.

What decision shall we come to, that a molecule apparently broken in pieces by the action of the current passes when it was stopped beforehand? The gas is re-formed across the metal leaf, and since it opposes no appreciable resistance to the current we must suppose it passes with the greatest ease. Besides, gases are easily electrolyzed as bodies in solution, and there is nothing to show that the phenomena, well substantiated in the case of electrolytes, are impossible in the Crookes tubes. All the radiations show selective absorption on the various bodies quite independent of the mass traversed. Metals stop light at a few thousandths of a millimetre in thickness, while one can see the radiations through several hundred metres of water. This is not true of cathode rays which according to Mr. Lenard are absorbed directly according to the mass traversed. May one not conclude that the action is in some sort mechanical? As we see them the facts in this singular phenomenon are contradictory. The hypothesis of bombardment presents gross difficulties, but it adapts itself marvelously well to the above view of the case.

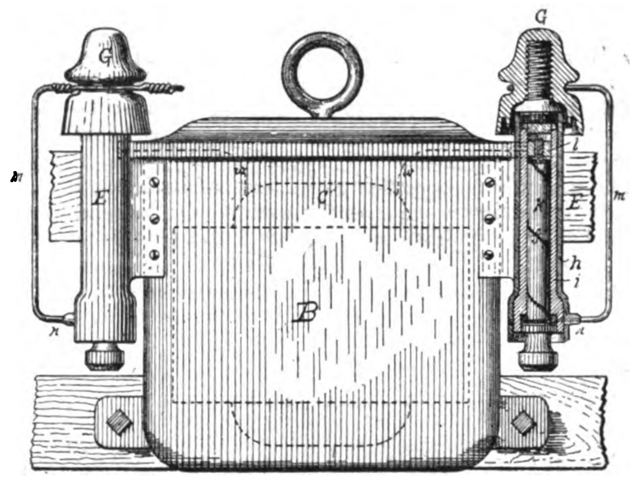
Whatever may be the final decision, the kinetic theory of gases has a new foothold of final proof; but many experiments are still needed before it will get there.

The Gamewell Fire and Police System at Jacksonville, Fla., is said to have been so disturbed by induction from high tension electric light wires that it has become dangerous even to attempt to handle the boxes at times. Mr. A. C. Farrand, agent of the company, has been investigating and rectifying the trouble.

WAGNER AND SCHWEDTMANN'S TRANSFORMER CUT-OUT AND INSULATOR.

Fusible cut-outs for the primary circuits of converters are usually placed on a convenient support near the transformer, and sometimes on the transformer box; but the wires coming from the supply-mains are always supported by separate brackets carrying porcelain or glass insulators, and attached to the wall or support near the transformer. The wires cannot be led directly from the transformer to the supply-mains, as their weight and the strain of the wires would pull them out of the coils. To avoid the expense and inconvenience of thus supporting these devices separately, Messrs. H. A. Wagner and F. Schwedtmann, of St. Louis, have devised a means by which they may all be combined.

The arrangement intended for this purpose is illustrated in the



Transformer Cut-Out and Insulator.

accompanying engraving. Each fuse cut-out consists of an outer metal shell or holder h and an inner shell of non-conducting material i inclosing a removable core k, also of non-conducting material, and carrying a fusible metal strip f. The wires w leading from the primary coil c of the transformer are connected with the terminals l of the fuses f, and make electrical connection through the fuses with the wires m passing out through the insulating bushings n to the insulators G, from whence they are led to the supply-mains.

By the construction adopted, the strain of the wires leading to the supply mains is taken up entirely by the insulators.

PHOTOGRAPHING THROUGH SOLIDS BY ELECTRIC RAYS.

Last week we published a special dispatch from Europe, in regard to the photographing through solids by Prof. Rontgen by means of vacuum tube light. The following dispatch from London of Jan. 11 says:—"Great progress has already been made with Prof. Rontgen's wonderful discovery of a new light, if that be a proper description of it, which I cabled a few days ago. Prof. Klupathy of the Pesth University has obtained even greater success in photographing concealed objects. He also varied the experiments by enclosing objects to be photographed in a variety of coverings. It has been ascertained that the light from Crookes tube penetrates not only organic matter, but also one metal, aluminum. Prof. Rontgen has sent rays of the new chemical light through aluminum plates an inch thick, and they went as clean through as if the substance had been glass. The same was the case with two sets of books, including many volumes, these he placed between a Crookes tube and an ordinary compass. Behind them was a wooden case with dry plate, and the result was as complete a photograph of the compass as is possible. It is perhaps no photograph in the ordinary sense, because no lenses are used. It is not a negative, but a positive plate that is obtained."

Another cable dispatch from London of the same date says:—"Scientists are greatly interested in the report of the experiments at Würzburg, repeated at Buda-Pesth, by which a positive picture is obtained by the agency of the Crookes tube through barriers of wood, cloth and flesh, and whole rows of books, bones, and metals alone remain opaque. But even of the latter aluminum is now discovered to form an exception. Prof. Thompson calls it a registration of shadows rather than a photograph, and it is curious that it can only be done without a lens. Photographers see no point in it for them, but its use in obtaining the minutiæ of a skeleton through any amount of flesh and muscle promises a revolution in surgery and medicine."

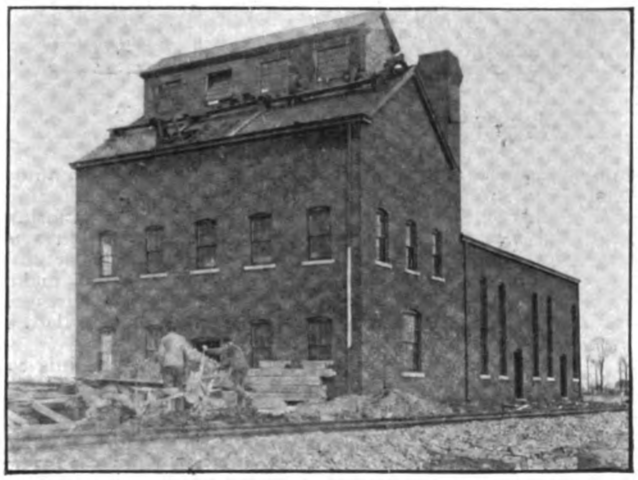
POWER TRANSMISSION.

THE CALCIUM CARBIDE PLANT AT NIAGARA.

BY ORRIN E. DUNLAP.

IT is expected that before this month ends calcic carbide will be made in the new plant at Niagara Falls. This is the first one of its kind in America and considering the great interest now centered on acetylene gas, which is made from calcic carbide, there is little wonder that close watch is being kept on the Niagara plant in anxious waiting for results to indicate the probable success of this new industry. The product of this initial plant will be sent to Philadelphia in barrels and there manufactured into acetylene gas to supply Southern Pennsylvania. The rights to manufacture calcic carbide under the Willson patent have been sold to capitalists in many sections, so that at present no fewer than 12 states are watching Niagara to learn more of the process of manufacture.

The new plant here being the first of its kind, it is but natural many interesting experiments will be made in it. At the start of operations it will be important to ascertain the amount of electric current which will prove the most economical, for so far the experiments have been made with current varying from 25 H. P. to 235 H. P. The contract of the company with the Niagara Falls Power



THE CALCIUM CARBIDE WORKS AT NIAGARA.

Company calls for 1,000 or more H. P., a force much larger than any used heretofore for the purpose.

The current is received all on one phase at 2,200 volts and used at a voltage of about 100. At the commencement it is likely that the furnaces will be operated with a current ranging from 100 to 1,000 H. P. and it is possible from the dimensions of the furnaces that a current of 500 H. P. will be found the most economical.

The present size of the Niagara carbide plant is 40 x 90 feet at the foundation. The structure, as shown in the accompanying engraving, is of brick, the front portion being two stories high, or 31 feet to the eaves. It contains a furnace room, a crushing and grinding room, a laboratory, a switchboard room, a transforming room and a room for the employees. The crushing and grinding portion of the outfit is to be of sufficient capacity to supply a plant of 50 tons capacity, whereas the capacity of the plant at the start will be at least 5 tons per day. A two-phase 75 H. P. motor will operate the grinding plant. In the furnace room four furnaces have been built, each containing cast iron crucibles 3 feet 6 inches long, 2 feet 8 inches deep, and 2 feet 2 inches wide. The current will be kept on each furnace for about three hours, one furnace being operated at a time. Each horse power used is supposed to give 20 lbs. of calcic carbide each 24 hours, and each pound of the product is supposed to produce a little over five cubic feet of gas. January will be a busy month at the plant, for on the 7th inst. the General Electric Company's force came on from Schenectady to install the electrical equipment, while the force from the parent plant in North Carolina and Mr. J. M. Morehead, of New York, the engineer in charge of the erection, are also here and will devote their united efforts to hurrying the plant to completion, so that by February 1, at the latest, the factory may be in operation.

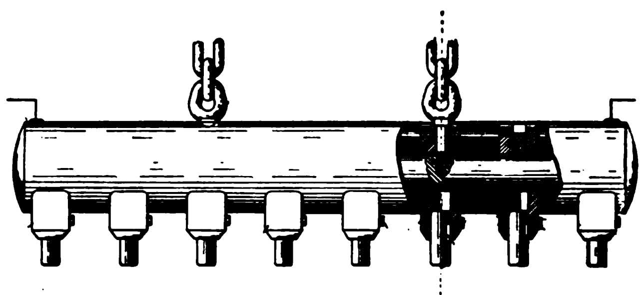
It is altogether likely that calcium carbide will be manufactured in the plant here at a cost not to exceed $5 per ton. In this connection the promoters of the plant give some interesting figures in stating that assuming that 20 pounds of carbide are produced each 24 hours for each horse power used, the amount made during 300 working days would be three tons per H. P. per year, and applying the 100,000 H. P. available from the present tunnel it would mean the production of 300,000 tons per year. This, they say, should produce at least 3,300,000,000 feet of acetylene gas, which, as its illuminating powers as compared with coal gas are as 10 to 1, would represent all of 33,000,000,000 cubic feet of this gas,—an amount that equals if not exceeds the annual output of coal gas throughout the whole United States. There is no doubt that other factories for the manufacture of calcic carbide to supply New York, Massachusetts, Ohio, Northern Pennsylvania, Indiana, Illinois, Rhode Island, Connecticut, Missouri, Michigan, Minnesota and other states are likely to be erected at the Falls because of its proximity to the fields from which the materials used in its manufacture are obtained, and also because of the great supply of cheap electrical power obtainable there.

DANIELS' MULTIPOLAR LIFTING MAGNET.

THE use of electromagnets for picking up and raising masses of iron in foundries and similar places has been proposed and tried to a limited extent; but the ordinary magnet with two poles is serviceable in this way only for small masses of iron of inconsiderable area. The use of a multipolar electromagnet, the poles of which are held in a rigid relation to each other and to the mass of iron to be lifted, is unsatisfactory except for application to masses or structures of iron of even surface.

To avoid this inconvenience Mr. W. P. Daniels has designed a form of multipolar "power" magnet shown in the accompanying engraving.

An important feature of the device consists in the con-



MULTIPOLAR LIFTING MAGNET.

struction of the pole-pieces in which there are provided the recesses. These recesses are adapted to receive pole extensions of wrought-iron, movable longitudinally in the recesses in the pole-pieces, their excursion being limited by set-screws, which project into the recesses and into the slots, provided within the pole extensions. The latter are prevented from falling out by the stops at the upper end of the grooves, while the extensions have an up-and-down movement limited by the length of the slots. The force of gravity will ordinarily be sufficient to withdraw the extensions and bring them to the lower limit of their excursion; but a spring may be added to insure the protrusion of the extension pole.

THE WATER POWER OF THE DRAINAGE AND SHIP CANAL, AND ITS TRANSMISSION TO CHICAGO.[1]

BY H. S. PUTNAM.

INCIDENT to the sanitary benefits of the Drainage Canal and especially to its use as a ship canal, a magnificent water power is made available which can be developed and utilized at a comparatively small expense. With the Drainage Canal, you are all more or less familiar, and its description here is not necessary. Its utilization as a ship canal has also been frequently agitated, and has been an important factor in its plans and construction. It may be some years before these plans are fully carried out, as the scheme is gigantic in its proportions and will require time and money to complete. However, upon the completion of the drainage canal a large portion of the expense of opening a deep water route from Lake Michigan to the Gulf will be covered. When we consider the vast importance of such a route to the whole Mississippi Valley, and ultimately, in connection with the proposed deep water ways to the eastward, to the whole country, in the matter of transportation facilities and freight rates, it is more than probable that the balance necessary to complete such a route to the Gulf will be forthcoming in the very near future.

The Drainage Canal when completed according to the present plans and contracts, will stop at Lockport and will have a flow of 300,000 cu. ft. of water per minute. After deducting say six feet for the slope on the surface of the canal, there will be available at Lockport about a twelve foot head of water. With a turbine of 85% efficiency, this will give us 5,800 available horse-power. Upon the completion of the canal, however, as a ship canal, with the flow at the full capacity—600,000 cu. ft. per min., a water power will be developed of immense value to that community, and also to this city. Lake Joliet just below the city of Joliet, is 76 ft. below the low water mark of Lake Michigan. Allowing six feet as before for the slope in the surface of the canal, we will be able to utilize the remaining head of 70 feet in two steps, one at Lockport, and the other at Joliet, of nearly equal amounts. As the tail races of the power used at Lockport can be turned back into the canal, no water will be lost, but it can all be utilized for the entire fall. Taking the efficiency of the turbine wheels as before at 85 per cent. and allowing a loss of one foot of the head in the rise of the water in the tail races and other obstructions to its flow, at each step, we have available 65,700 actual horse-power, in two steps of nearly equal amounts at Lockport and Joliet. The flumes for the utilization of this water power can be put into the canal when it is being built, at practically no additional expense, and the tail races can be built at a merely nominal figure as compared with the great amount of power to be developed. Thus in this case we avoid the common objection to water powers, namely, the immense cost of the necessary dams, etc., so as to make the water power available, compared with the amount of power used. The interest on the necessary money outlay, often exceeds the cost of coal where steam is used.

After the ship canal is built, provision being made for water power flumes, it is more than probable that all necessary tail and head races can be constructed for less than $50,000. Then again we have an available market for the whole of this immense power. It is probable that Joliet and Lockport can use only a small portion, but Chicago, with its population of two million, and a daily consumption of between two and three hundred thousand horse-power, offers a grand market. That this power can be transmitted to Chicago economically and profitably is what I propose briefly to show.

I will endeavor first to show the feasibility of the project from an engineering standpoint, and second, the financial phases of the question. We will first consider the power plant.

In building the retaining walls and locks for the ship canal at Lockport and also at Joliet, the flumes and openings in the wall for the water power can be left at practically no additional expense, and what little there may be, the authorities will certainly feel justified in creating in consideration of the financial returns that they can obtain from a rental of the power. Therefore we have only to consider our discharging tail race or shunt around the ship locks, as far as the handling of the water is concerned. Such a tail race would necessitate the removal of less than 25,000 cu. yds. of material, mostly rock. At Lockport this tail race would have to be constructed, but at Joliet it is very probable that the water could be discharged directly into the river at a very small expense. At the prices now prevailing in the country for this class of work, from 20 per cent. to 25 per cent. lower than the prices current at the time the contracts for the drainage canal were let, owing largely to improved machinery, this excavation for both plants would cost less than $25,000. Adding $25,000 more for the necessary retaining walls, would make this part of the plant cost approximately, $50,000.

The turbine wheels can be very easily made in pairs, each pair connected directly to the electrical generator, or whatever machinery it may be required to drive. With the head under consideration these pairs can be made of 3,000 horse-power each, 20 such wheels, say 10 in each station, being required for the entire plant. Ordinary turbine wheels can be bought for $1.00 per horse-power. Especially designed wheels, with necessary flumes, gates, regulators and erected in position, for about $5.00 a horse-power. To cover special features however, and also the two station houses, which would not be expensive, I have estimated the cost of the entire power plant with the turbines ready to run at $500,000, or $10.00 per horse-power. This figure can certainly be very considerably reduced.

Next, we must consider the method of utilizing this power, but more especially, in the present instance, its transmission to Chicago, a distance of 40 miles. To transmit this power by hydraulic pressure, even if practicable, is out of the question in the present case, as the only water available in sufficiently large quantities is from the canal, and there would be objections to returning the sewerage back to the city in this way. Compressed air is more feasible, but compressed air engines are not economical, and neither is the use of compressed air, unless it is reheated before being used, and also transmitted at a comparatively low pressure, which means large pipes. In point of convenience, ease in handling, adaptability and economy in transmission and use, electricity as a motive power, stands foremost at the present time. In the development of the immense water power at Niagara and its transmission to Buffalo, all these different methods were carefully considered and electricity finally adopted. By the use of electricity about 80 per cent. of the power developed by the turbines can be delivered to the consumers in Chicago; certainly a better showing than is made by the compressed air plants now in operation.

Adopting electricity, therefore, as the means of transmitting this power, the alternating current is selected on account of its flexibility, ease of conversion and the high voltage it enables us to use in its transmission, thus effecting an immense saving in copper. A low number of alternations per second, not exceeding 30, is selected so as to avoid the induction losses which would be excessive at a higher frequency. The use of this low frequency may interfere somewhat with the use of arc lights on the circuit directly, but by the use of proper rotary transformers this can be rectified. For all other purposes there is no objection to this frequency.

As it is not advisable to build generators of too high a voltage, the generators in question should have a voltage of about 2,000 volts, and in order to be directly connected to the turbines, of 3,000 horse-power, or 2,250 K. W. capacity each. It would be preferable to make these as large as possible and a careful consideration of the turbine wheels to be used might enable their size to be increased. The polyphase current would be adopted as offering numerous advantages over the single phase, especially in the use of motors, and the three phase instead of the two phase current on account of the great saving in copper in the transmission line, a very important consideration when the energy must be conveyed 40 miles. Step-up transformers changing the voltage from 2,000 to 20,000 volts should be used, as it would be impracticable to transmit this energy 40 miles at a low voltage on account of the immense amount of copper necessary. It requires 3,000 tons of copper at 20,000 volts. If we used 2,000 volts instead, one hundred times this amount would be required for the line, with the same percentage of loss. For the purpose of avoiding the inductive and condenser losses on the line, an overhead pole line is very much preferred, and this can be constructed very nicely along the banks of the canal. Owing to the inductive effects of large wires, comparative small wires are desirable, and consequently the circuits must be sub-divided. In this case No. 0 wire has been selected. It will require 30 circuits of three wires each of No. 0 wire to transmit the energy in question with a 10% loss. This will require 3,600 miles of No. 0 wire weighing over 6,000,000 pounds. As illustrating the importance of the size of the wire with inductive currents, if 0000 were used, it would require one-third more copper. The line has been computed on the basis of a 10% loss of energy, as probably the most economical in the present instance. Mutual induction between the circuits can be avoided by cris-crossing the wires on the pole line so as to counteract any mutual inductive effect between the adjacent circuits. Bare copper wire has been selected not only on account of its cheapness, but also because any ordinary insulation could not be relied upon at the voltage contemplated, so dependence will be placed upon the best grade of insulators for the insulation. A distance of 12 inches between the wires has been selected, as establishing a partial balance between the inductive and condenser effects. It is probable that with a very large load of motors on the circuit, as will be the case, the inductive losses on the line would be somewhat greater than has been taken. A considerable margin has been allowed for this in figuring the line, and the difference in phase caused by the highly inductive load can be rectified by the use of condensers. The use of synchronous motors, especially in the larger sizes, would also tend to prevent distortion of phase due to inductive losses.

For the purposes of this paper, the distribution and utilization of this energy for power purposes in large units is all that is contemplated. For local distribution, especially for lights and smal

1. A paper read at a meeting of the Illinois Chapter of the American Institute of Architects

powers, a local company would undoubtedly be organized to carry out that part of the business, or power could be furnished to the companies at present engaged in electrical generation. It is therefore probable that the power transmitted to the city would be utilized in units of considerable size, either by direct transformation to currents of lower voltage, suitable for general distribution for lighting and power circuits, or local transformation for power purposes at the plants of large consumers. These step-down transformers have been considered in the estimated cost of the plant hereafter made, but not the local distribution from these to the general consumer, as that is not essentially different from the methods already employed by the present companies, and presents no difficult engineering problems. Suffice it to say, that the alternating current can be distributed with greater economy and a more efficient and better balanced service than is possible with the direct current, when proper attention is paid to its details. Polyphase motors are also more efficient and require much less attention than direct current motors.

In the foregoing discussion, a 2 per cent. loss has been assumed in the step-up and also in the step-down transformers; a 10 per cent. loss in the line, and an efficiency of 95 per cent. in the electrical generators, and 85 per cent. in the turbine wheels. Apparatus is in use to-day showing fully as good results as have been assumed, and there is no reason why these figures cannot be equaled, if not improved upon, in the plant under consideration. These efficiences have of course been assumed under the conditions of full load, but the efficiencies of the apparatus as manufactured to-day would be only slightly less at any probable underload, while the losses on the line would be decreased. At full load, according to the above figures, the consumers would be furnished with 82 per cent. of the power received from the water wheels, and it is not probable that the efficiency of transmission would fall below 75 per cent. under any ordinary conditions of underload.

From the above it is readily seen that there are no serious difficulties in the way of transmitting this power to the city from an engineering standpoint. Financially the project is even more attractive. The following estimate has been prepared from actual figures which have been submitted to the writer by manufacturers, but in all cases increased in size to cover unexpected contingencies, and also the extra cost of getting only the very best of everything, irrespective of cheaper apparatus that might be obtainable, but possibly of inferior grade.

ESTIMATED COST OF PLANT.

Water-power plant, turbines and buildings complete	$ 500.000
Tail-races and discharges.......	50,000
Electric plant, including generators, transformers, etc...... ...	1,250,000
Transmission line, 3,600 miles No. 0 wire, pole line, etc..........	1,000,000
Distribution, sub-stations in Chicago............................	50,000
Engineering and sundries...............	150,000
Total cost...........................	$3,000,000

INCOME AND EXPENSES.

Rental of 50,000 H. P. at $25 per year....		$1,250,000
Interest on investment at 4 per cent....	$120,000	
Depreciation at 4 per cent..........................	120,000	
Repairs and supplies.	10,000	
Labor and superintendence.........................	40,000	$ 290,000
Excess of income over expenses...		$ 960,000
Deducting $5.00 per H. P. rental to Drainage District...........		250,000
Net income...		$ 710,000

Or 27 per cent. on the investment.

As will be at once seen from the above estimate, it is very liberal. In all probability the cost of the plant can be kept below two and a half millions. The charge of 4 per cent. depreciation on such a plant is excessive, as much of it is subject to but little, if any, depreciation. The interest charge is hardly an operating expense, but is put in on account of the prevalent custom to-day of bonding an enterprise to the full extent of the investment, thus making the interest a first lien on the income.

The charge of royalty or rental on the part of the Drainage District is an uncertain quantity, so it has been estimated at $5.00 per H. P. per year. This to the writer would seem to be an ample charge as compared with similar charges made at Niagara, but under very different circumstances.

The price charged consumers for the power, $25.00 a year per horse-power is, I think, perfectly practicable. According to the best estimates, it costs large consumers of power between $30.00 and $40.00 a year for power where it is produced by steam in large quantities. It costs small consumers very much more than this. A sliding scale of charges should, of course, be adopted according to the amount of power used. Consequently there should be little difficulty in disposing of the power at an average price much above that assumed in the estimate.

It was the original intention of the writer to take up some of the problems of the use and distribution of this electrical energy in the city, and the possible effects it might have, but this paper has already assumed sufficient proportions. Suffice it to say in conclusion, that we can scarcely over-estimate the importance of the Drainage and Ship Canal as a source of power to the City of Chicago, and that both from an engineering standpoint and financially it offers a very attractive field for our attention.

NIAGARA PLANT OF THE PITTSBURGH REDUCTION CO.

The works of the Pittsburgh Reduction Company have now been in operation at Niagara Falls for several months. The necessary electric current has hitherto been furnished through four of the General Electric Company's 400 K. W. rotary converters, but owing to a considerable increase in the reduction plant they have been found inadequate for the service, and each of these 400 K. W. converters is about to be replaced by one of 600 K. W. capacity. The new machines will be mounted upon the same base frames as the 400 K. W. converters and thus the converter plant will be increased one-half without any increase in floor space. A fifth converter of 600 K. W. capacity will be installed beside the others and will be similar to them in every respect. The total rotary converter capacity will then be 3,000 K. W. Including the transformers installed in the works of the Carborundum Company and the Calcium Carbide Company at Niagara Falls the General Electric Company will have furnished 5,000 K. W. capacity of transformers for operation in connection with the Cataract Construction Company's system.

NEWS AND NOTES.

CRUCIBLE CAST STEEL IN THE ELECTRIC FURNACE.

It has lately been proposed to prepare high-class crucible cast steel in an electric furnace (of a continuous type) provided with a basic lining similar to that already freely employed for ordinary furnaces used in the manufacture of lower grades of steel and of ingot iron. In the case of the preparation of a fine cutlery steel the purest procurable raw material would be used, certain samples of spathic iron ore fulfilling this requirement. The roasted ore would be reduced with wood charcoal in an electric furnace, and its contents of carbon, if too low, corrected by the addition of spiegeleisen. According to a recent article in the *Zeitschrift fuer Elektrochemie*, the computed cost of the finished steel in bar, even when spiegeleisen has been requisite, is about £12. 10s. per ton, a price by no means excessive. The whole operation can be conducted in a neutral or slightly reducing atmosphere, and it is practicable to maintain the temperature, at all stages of the process, at a point well above the melting point of the product, a considerable advantage.

A CITY ELECTRICIAN FOR BUFFALO.

Mayor Jewett of Buffalo advocates the appointment of a City Electrician, in these words, which are to be found in his annual message submitted to the Common Council on the 6th inst:—"Electricity is becoming so potent a factor in civilized life and figures so conspicuously in municipal problems that it seems to me that it would pay the city to employ an electrical expert, to be appointed by the Board of Public Works and known as the City Electrician. He should have charge of all electrical wires in the public streets and superintend the construction of all new electric lines, particularly those for the transmission of Niagara Falls power, and all new street railroad lines. It should be his duty to see that all proper precautions are taken to prevent the destruction by electrolysis of the water and gas mains now in the streets. The damage from this cause has been very large in some cities, and the authorities of Buffalo ought to be on guard to prevent a similar occurrence here. Plenty of work could be found for a City Electrician to do, and I believe the creation of such an office would be a wise and desirable step."

DISCREPANT "OUTAGES" AT CINCINNATI.

The police reports for December to the Board of Administration of Cincinnati, were filed a few days ago. The police reported 9,690 hours and 18 minutes' outages, and the Edison Company but 5,241 hours and 20 minutes' outages, a difference of 4.448 hours and 58 minutes. This involves a deduction of $97.88 from the Edison Company's bill. The Board decided hereafter to accept the police report as correct and final. There may be litigation on the matter, but the Board feels the position it has taken is demanded by regard for the public interests, and will maintain it.

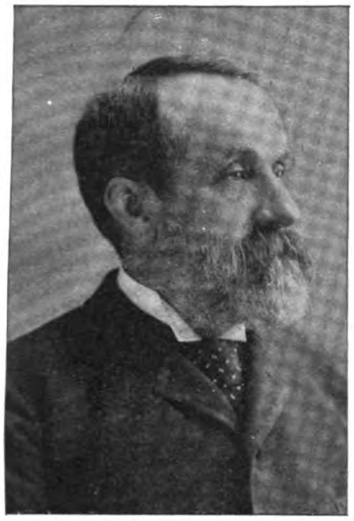
ONLY 1,782 MILES.

The steam railroad track laid in this country in 1895 did not exceed 1,782 miles, or the smallest quantity for any year during the past twenty.

MAGNETIC OBSERVATIONS ON HARDENED STEELS have led Mr. J. O. Arnold, in his paper on "The Influence of Carbon on Iron," read at the Institution of Civil Engineers, to the conclusion that (1) the magnetic permeability varied inversely as the carbon present; (2) the permanent magnetism was directly proportional to the carbides of iron present; and (3) in iron containing between 0.1 per cent. and 0.9 per cent. of carbon the permanent magnetism was directly proportional to the sub-carbide of iron present.

Telephony and Telegraphy.

THE NEW HOME OF THE PROVIDENCE, R. I., TELEPHONE COMPANY.[1]



Henry C. Cranston, President.

THE tremendous advance in telephone service which has characterized the history of the sound transmitter from its advent a comparatively short time ago to the present day, when it seems as if human invention can hardly bring it much nearer perfection, has in no city been more marked than in Providence.

Whatever improvement in telephonic service has been made has been at once applied here. The local office handles an immense amount of business, and with what success and ability the business men of Providence can best attest. From its modest beginning to its present position as a system with upwards of 5,000 subscribers, the advance has been steady, ever growing—ever improving.

The last step to be taken was that made when the old office in the Butler exchange was abandoned for the fine building which the central office of the company now occupies—a building built for and by the company, and with its every part specially adapted to some feature of the system's work.

The handsome new building of the Providence Telephone Company, in this city, a cut of which is herewith presented, was completed and occupied by them in April of 1895. Their old quarters in the Butler Exchange building becoming inadequate for the latest improved appliances, and the business demands, the construction of this building became necessary to comply with the outlay for increased facilities for the underground and switchboard systems.

The building is located on the easterly side of Union street, between Fulton and Washington streets, and is built in the Italian Renaissance style of architecture, of granite and Indiana Oolitic limestone for the first story and brick and white terra-cotta for the two upper stories.

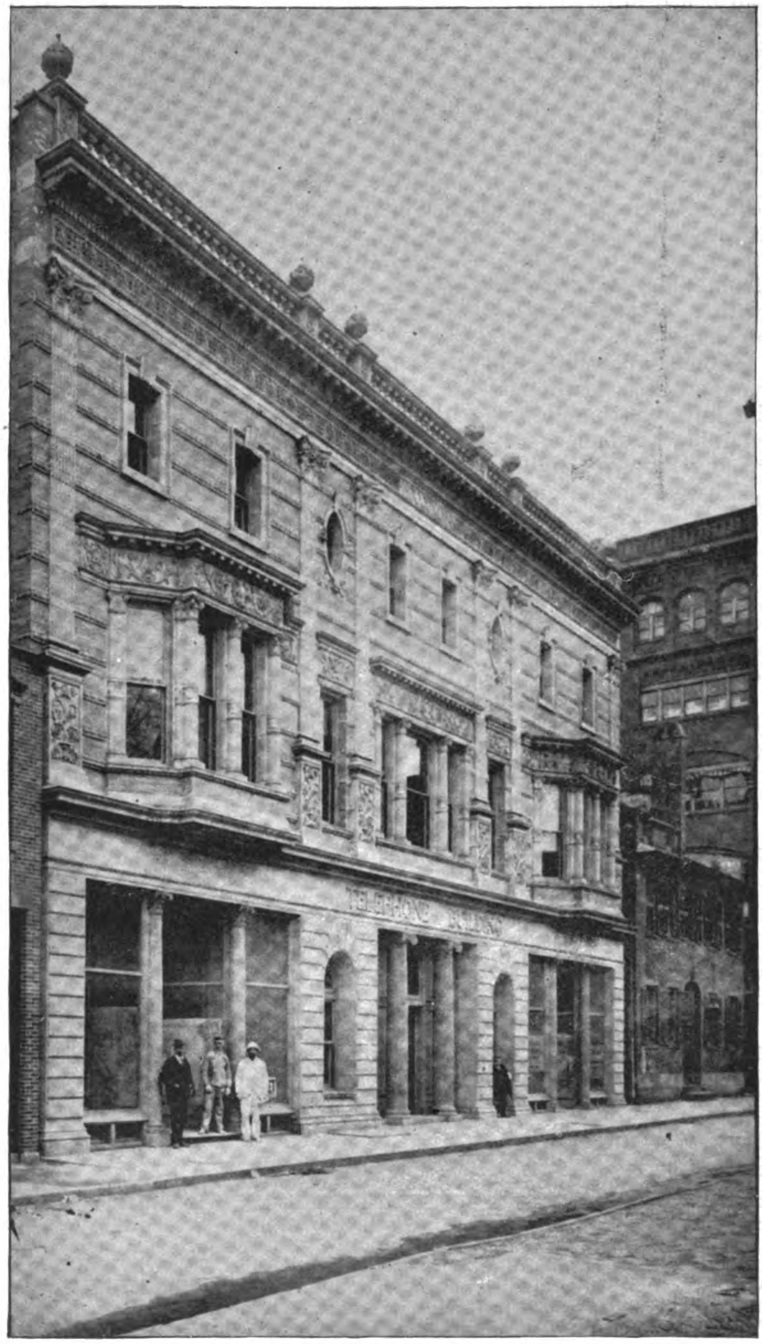
The location could hardly be improved on. Close by the building are the large dry goods houses. Just below it begin the banks and the larger business houses of varied interests. It is convenient for the business man from out of town who wishes to call up his home place, and equally convenient for its subscribers in town.

The building itself is a handsome one, and has a most unique appearance. The first story main entrance is flanked on either side by Ionic columns of polished granite, and leads into a spacious and well-lighted lobby, which has been furnished with sound proof booths, for long distance and local telephone service. The staircase to the second story leads to the business and directors' offices, the offices of the president, treasurer and general superintendent.

On the third floor is located the electrician's department, operating room, distributing room for all the wires terminating in the building, and the retiring room for the female operators.

The transfer from the old office to the new was accompanied by many sweeping changes and radical improvements in the system. The company keeping in line with similar systems in other cities, had gone into the work of laying the wires underground, an improvement the value of which can readily be estimated.

A new switchboard to care for 5,000 subscribers had to be installed, in this change, at an outlay of $60,000, and for the underground subways with the cable laid therein, a very much greater sum was expended. Some eight miles



Front View of Providence Telephone Building.

of trench were excavated, varying in depths from 4 to 15 feet, and 250,000 feet of pipe laid in these trenches. Each pipe is three inches in diameter, and is capable of receiving a cable of 220 wires.

By the use of the underground service to reach the sub-

1. *Providence Telegram.*

scribers, the multiplicity of overhead wires have been removed, and the possibility for line interruptions, such as has been experienced in the past, from high winds and ice storms, will be removed. The territory of the company embraces Rhode Island, and the towns of Attleboro and North Attleboro. There are 5,200 subscribers connected with their service and some 33,000, of which 22,000 are made at the Providence office, calls are answered and connections made daily in the system.

To the several suburban exchanges, metallic circuits are connected from Providence central, which give the subscriber perfect service to these several points. The long-distance service receives special attention, and the quarters set aside for it in the building are perhaps the finest furnished in any city of similar size in the country. The improved appliances, the comfort which one may enjoy, and the excellent service itself are all greatly appreciated by those busy men whose interests demand that they may have speedy communication with their business associates in distant cities.

At the Providence office there are sixty lady employees whose duty is to answer calls and make connections from the subscribers. All of the suburban exchanges are kept up-to-date in their equipment, and the use of lines through these out-of-town offices is made as convenient and as free from annoyance as the use of a line, the connection for which is made without going beyond the Providence exchange.

The company has had an existence of fifteen prosperous years. It is at the present time recognized as one of the leading quasi-public institutions of the city, and one which is doing as much in advancing the city's business interests as any other existant. The Providence Telephone Company was organized in 1880 with a capital of $35,000, which has been increased from time to time, as the demands for the service has required, until it is now $800,000. The men connected with the company include many of those best known in the city's life. Representative names are those which appear upon the company's printed matter as the men who control its work and guide its fortunes.

The board of directors and officers are as follows: Directors, Henry C. Cranston, Henry G. Russell, R. G. Hazard, R. M. Larned, James H. Chace, J. E. Hudson, H. F. Barrows, F. H. Peckham, Jr., S. U. Starkweather, Albert O. Morgan, Dexter B. Potter, Samuel P. Colt.

President, Henry C. Cranston; vice-president, Albert O. Morgan; treasurer, Charles T. Howard; general superintendent, Albert C. White.

THE RELATIONS OF POSTAL AND WESTERN UNION.

An official who speaks with authority on telegraph affairs says of the relations between Western Union and Postal telegraph companies from 1883 to 1887: "There were several comparatively small telegraph companies fighting one another and the Western Union, causing the greatest confusion in rates and disturbance of honorable business methods. Finally the Postal Telegraph Co. acquired some of these companies and the Western Union others. The folly of cutting rates, giving rebates and the like became apparent and an agreement was made to put an end to such practices. A good many rates were reduced in the process of doing so and the ruinously low rates were increased to reasonable figures. That arrangement has continued until now with decided advantage to both companies. The agreement has not expired, and I know of no reason why it should be terminated. On the contrary, there are many reasons why it should not. There is no war between the companies. Competition is very sharp, resulting in higher efficiency in the telegraph business than ever before. Neither company has the slightest interest in the other and both are naturally on their good behavior. There has never been any division of territory by the two companies and such a plan of business will never be adopted in my judgment."

St. Joseph, Mo.—It is stated that the new Citizens' Telephone exchange at St. Joseph is now in good working order with about 500 telephones in operation. The exchange was opened December 1, with 400 instruments connected, and Mr. G. A. Moss, the manager, says that he expects to have 800 going in a month or two.

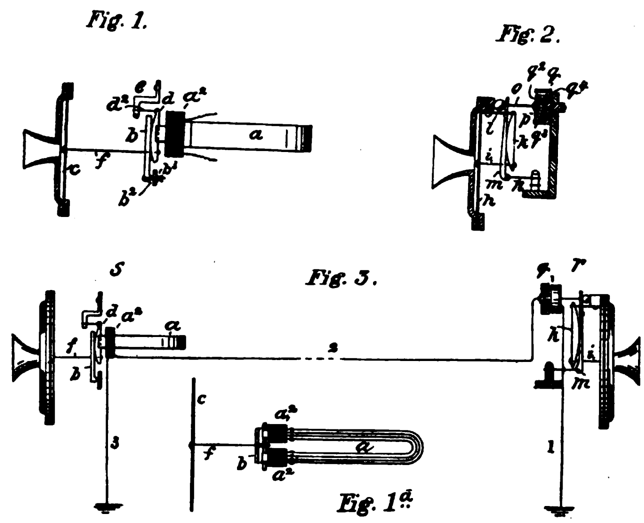
FIELD'S COMPENSATING TELEPHONE.

It is found in the practical transmission and reproduction of articulate sounds that the feeble and rapid fluctuations of current are affected by various electrical characteristics of the circuit in a different degree from the slower fundamental vibrations. They experience greater opposition from the impedance in the conductor and suffer more serious dissipation in the insulating medium of the circuit. Hence if the vibrations of the transmitted current were of amplitudes in strict proportion to those of the sound-waves impinging upon the transmitting-instrument, the reproduced sounds would be of quite different quality from the original sounds, the characteristic harmonics having been degraded or eliminated through various reactions of the circuit.

Mr. Stephen D. Field in a recent patent describes means to compensate for this unequal degradation of current pulsations of different periods and amplitudes by means of a mechanical device in the telephone which acts to accentuate or magnify the more rapid and feebler vibrations while diminishing the amplitude of the heavier vibrations. By thus transforming the mechanical vibrations of the transmitting diaphragm into distorted or disproportionate vibrations in the electric current, it is possible to compensate for the unequal effects of the circuit upon the different vibrations and to produce in the receiving-instrument mechanical vibrations in strict conformity with those of the transmitting-instrument.

In long insulated conductors or cables the static effect upon varying currents is particularly prominent. This so-called "retardation" is in fact an absorption of the energy of the current, and results in the extinction of the characteristic harmonic undulations. The invention therefore applies particularly to transmission through long cables or between distant stations.

The invention contemplates the interposition between the vibrating diaphragm and the transmitting device proper—the



Field's Compensating Telephone.

current-modifying portion of the transmitter—of a modified system of compensating-levers of the type known as "Houdin's compensating device." One of the levers is pivoted at one extremity and has its other extremity connected with the transmitting device. The other lever, which abuts upon the first-mentioned lever and has a curved surface rocking upon that lever, is also movably supported at one extremity, and has its other end fixed to the transmitting-diaphragm. The movements of the diaphragm are thus imparted to the transmitting device through the medium of these levers, whose point of contact, and hence whose ratio of movement, shifts in proportion to the amplitude of the sound vibrations.

The instrument is so adjusted that the vibrations of large amplitude cause the point of contact of the levers to shift in such a way that the movement imparted to the transmitting device is less than the excursion of the diaphragm, while when the diaphragm vibrates feebly the motion imparted through the levers to the transmitter are magnified.

The invention is applicable not only to transmitting but to receiving telephones. In its use in the latter instrument its function is obviously to magnify or exaggerate mechanically the degraded harmonic pulsations while diminishing the fundamental vibrations, thus in a manner restoring the transmitted impulses to their original condition.

Fig. 1 of the engravings is an elevation of the essential parts as applied in a receiving-telephone. Fig. 1a is a partial plan view of the instrument shown in Fig. 1. Fig. 2 is a sectional view of the same device in use with a transmitter of the granular carbon

type. Fig. 3 illustrates a transmitter such as shown in Fig. 2 connected in an electric circuit with a receiving-instrument like that shown in Fig. 1.

The receiving telephone in Fig. 1 comprises the permanent magnet *a*, carrying on its pole-pieces coils a^2, an armature *b* for the magnet, a diaphragm *c*, and a system of compensating-levers and mechanical connections between the diaphragm and the armature. The armature *b* itself is used as one of the compensating-levers. A lever *d* co-operating with this is the other. Armature *b* is lightly supported upon a knife-edge b^2, being held in place by link b^3. Between the pole-pieces of magnet *a* lies a lever *d*, which is supported at its upper extremity on a light spring d^2, fixed in a bracket *e*. The surface of the lever *d* which abuts upon the face of armature *b* is curved, so that as the armature rotates about its pivotal point b^2 the point of contact between the parts of contact *b* and *d* is shifted toward or away from the fulcrum b^2. The yielding spring d^2 permits to the lever *d* a sufficient longitudinal movement to avoid the sliding of its surface upon armature *b* and consequent friction. The free extremity of lever *d* is connected by a thin wire *f* with the centre of diaphragm *c*.

Referring to Fig. 2, it will be seen that the features shown there comprise essentially the same parts. The diaphragm *h* is connected through a wire *i* with one extremity of the curved lever *k*, whose other extremity is carried upon a yielding support *l*. The convex surface of lever *k* bears upon the flat surface of another lever *m*, supported on a spring *n*, the free extremity of the lever *m* being connected through a rod *o* with the movable carbon plate or electrode *p* of the transmitting device *q*. It has a small diaphragm q^2 carrying the electrode *p*, and constituting the cover of a cup-shaped receptacle containing granular carbon q^3 and having fixed to its wall another electrode q^4.

The operation of these instruments may be described in connection with Fig. 3, in which a transmitting-telephone is represented in a circuit 1 2 3, extending between two stations *r* and *s*. In this figure the levers are represented as being so adjusted that the point of contact between them is substantially intermediate of the point of connection with the diaphragm and that of connection with the transmitting device *q*. In this case the feeblest vibrations which disturb the diaphragm to the slightest extent, will not be perceptibly magnified. A slight vibration of the diaphragm to the right will obviously rotate the lever *k* about its support *l*, and this movement will be communicated to lever *m* and thence to the movable electrode in the transmitter *q*. A large excursion of the diaphragm, however, will produce a large movement of lever *k* to the right, whereby the point of contact between that lever and lever *m* will be shifted to a place nearer the fulcrum of lever *k* and farther from that of lever *m*, so that the movement of the electrode q^2 will be less than the excursion of the diaphragm. The vibrations imparted to this electrode will hence be of less amplitude than the original sound vibrations, and the amplitude of the undulation produced in the current by the change of resistance in transmitter *q* will be of correspondingly reduced proportion.

If desired, the instrument may be so adjusted that the normal point of contact between levers *k* and *m* is farther from the fulcrum of lever *k* and nearer that of lever *m*. Obviously, with such an adjustment the feeble vibrations, which disturb the diaphragm only slightly, would be magnified, the corresponding vibrations imparted to the transmitter-electrode from the extremity of lever *m* being of greater range than those of lever *p*. Thus the undulations of current in the circuit corresponding to fundamental acoustic vibrations would remain in direct proportion to the acoustic vibrations, while the amplitude of the harmonic vibrations would be magnified. At the receiving-station *s* also the instrument is adjusted to reproduce the minute vibrations in their normal proportions and the coarser vibrations in reduced proportions. A heavy pulsation through coil a^2 will so reduce the attraction of the permanent magnet upon its armature *b* that the latter will move outward, and hence will shift its point of contact with lever *d* nearer to the fulcrum of lever *b* and away from the fulcrum of lever *d*, reducing the movement imparted to the diaphragm through wire *f*.

If the conductor 2 were a cable characterized by high static capacity and absorption, the transmitting-instrument might be so adjusted as exactly to compensate for the degradation or modification experienced by the undulatory current in traversing the cable—that is, the transmitter would be adjusted to such a relation between levers *k* and *m* that the overtones would be just sufficiently magnified to compensate for their increased liability to absorption or obstruction, the fundamental tones being somewhat diminished in volume. This distorted transmitting-current would then result in a current at the distant station *s*, whose fluctuations would be exact counterparts of the original acoustic vibrations.

THE TELEPHONE IN THE BRITISH NAVY.

The British Admiralty appear to have grown tired of experiments with the voice pipe in warships, and are about to try experiments with the telephone. When the cruiser Fox had her steam trials the homacoustic voice pipe was fitted, and it was so arranged that there should be no leakage of sound; but the rattle of the machinery soon proved that this contrivance was faulty, and that the voice was inaudible at the other end. In the Rurik there are no fewer than fourteen telephone stations, and the Russian officers declare that the system works admirably. In the Majestic a moderate test is to be made, as only three distances are chosen—short and straight, long and tortuous, and intermediate.

COLVIN'S BATTERY TELEPHONE CIRCUIT.

IN a patent recently issued to Mr. F. R. Colvin, of New York, that inventor describes a novel arrangement of battery and transmitter in a telephone circuit, by means of which increased effect is obtained.

It is evident that with a circuit such as depicted in Fig. 1, where all instruments are in series, the receivers add together in inductance to cut down the effectiveness of telephone transmission, and what is of still greater practical effect the resistances of the transmitters add together to cut down the ampere value of the current, and thereby reduce the degree of fluctuation of the talking-currents. The strength of the battery-currents could in a measure be increased by placing the transmitters and receivers in parallel branches of the circuit, the battery still remaining in line, as shown in Fig. 2. In such arrangement, however, by reason of the high resistance of the transmitters, the main body of the current would follow the receiver branch and the strength of current in the transmitter branch would be low, thereby lowering the degree of current fluctuation under the voice-waves.

Mr. Colvin finds that the best results are attained when the

Fig. 1.

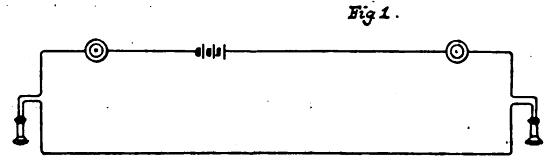


Fig. 2.

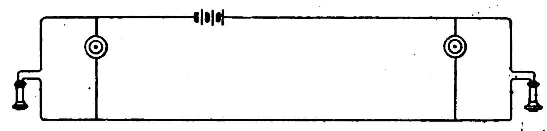


Fig. 3.

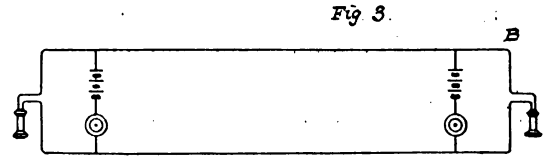
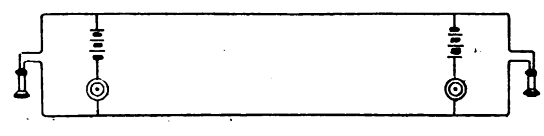


Fig. 4.



COLVIN'S BATTERY TELEPHONE CIRCUIT.

battery and the transmitter are both in the same branch and the receiver and transmitter branches are in parallel, as shown in Figs. 3 and 4. In such an arrangement it will be seen that the entire strength of the battery is exerted in the transmitter branch, the home and distant receiver receiving current in parallel, and therefore combining to lower the resistance of the circuit. The high resistance of the transmitter at the receiving end of the line diverts most of the current through the receiver branch. For example, suppose the transmitters have each a resistance of six hundred ohms and the receivers a resistance of seventy-five ohms. The strength of the incoming current in the receiving branch at the distant station would be about eight times as great as in the transmitter branch.

It will be noted that the transmitting-batteries in Fig. 3 have similar poles to line, whereas those in Fig. 4 have opposite poles to line. Mr. Colvin finds that the transmission is substantially of the same intensity in the two arrangements, a feature of considerable importance in practice where a number of circuits are to be interconnected through a central station, since it makes no practical difference how the two stations desiring communication have their circuits connected. Moreover, in installing or repairing a system no testing is required to determine the polarities of the wires, and therefore a saving of time and expense is effected.

It is evident that more than two stations may be used on the same line, the instruments always being placed in parallel with the battery interposed in the transmitter branch.

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CONTENTS.

MUNICIPAL TELEPHONY.

THE agitation which is being carried on by some who believe that the government can operate successfully all enterprises of a commercial nature better than they can be handled by private individuals or companies has resulted in the establishment in the United States of a number of municipal electric light stations. The results which have been attained in the operation of these stations, viewed from the standpoint of the tax-payer, have been anything but encouraging, and we can recall but a few instances in which even a barely satisfactory showing is made,—and these only due to conditions which unfortunately do not obtain in the large majority of cases. It is not our purpose to enter here into a discussion of this question as applied to electric lighting, but we refer to it because recent events indicate that municipal telephony may be the next thing brought forward as the panacea for all telephone evils. Admitting that nothing stood in the way of such a proceeding, so far as patent rights are concerned, what are the arguments that are advanced by the advocates of the plan? They are identical with those of the electric lighting municipalites. In this instance, however, in order to find material for the substantiation of their claims, recourse is had to examples of European municipal or governmental telephony. The actual conditions of telephony in all the principal countries of Europe are admirably given in the book entitled "The Telephone Systems of the Continent of Europe" by Mr. A. R. Bennett, which was reviewed in the ENGINEER of July 17, 1895. This book has become the bible of the devotees of the new cult. But, as shown by our reviewer of Mr. Bennett's book, the conclusions drawn by the author were not warranted by the facts, and also arose largely from the failure to take into account the variant purchasing power of money in different countries. Mr. Bennett's aim has all along been directed towards securing municipal or governmental telephony in English cities, and it was largely due to his agitation of the subject that a Parliamentary Committee was appointed to inquire into the matter of telephone rates, which committee examined a large number of persons. The report has not yet been published, though several months have elapsed since the close of the hearings. But that Mr. Bennett's own countrymen are not all in accord with his views becomes evident in perusing the discussion of a paper entitled "Municipal Telephony," read by Mr. Bennett before the Northern Society of Electrical Engineers, at Glasgow, Scotland. This paper is based largely on the facts and views given in Mr. Bennett's work above referred to, and hence need not be gone into again minutely at this time; but the discussion brought out some points of interest which are particularly applicable to conditions existing in the United States. Thus, Mr. Henry Edmunds pointed out that in the case of Trondjeim, Sweden, a town of 30,000 inhabitants, selected by Mr. Bennett as a shining example of municipal telephony, there were no royalties to pay, no way leaves, no night service, no telegram service. With nearly 800 subscribers there were no multiple switchboards! Mr. Edmunds also pointed out that if each small town had its own system, with varying rates, varying conditions, and varying management, the confusion could be better imagined than described.

But there is one point which those who advocate municipal telephony are apt to lose sight of and that is, the necessity of giving the subscriber the power to communicate not only with parties in his own city but with those in other cities within a thousand-mile radius. That no city would or could undertake to place such a service at the disposal of its subscribers goes without saying, and yet it is equally certain that no telephone system could be complete to-day without it. The only alternative would be to put the large majority of subscribers to the necessity of paying for two services, one local and the other long distance. This, of course, is based on the assumption that the interurban or long distance lines are worked independently. To avoid such a condition of affairs there seems to be only one way out, and that is, for the government itself to take over the entire telephonic business of the country. This proposition viewed from the financial standpoint alone in these days when the government needs loans of $100,000,000 for running expenses is too ridiculous for serious discussion. Even the British Post Office, with the statutory power to acquire the telephone, under the general Telegraph Act, has not availed itself of its rights, but has, with a few exceptions, preferred to allow the existing companies to do the work on payment of one pound royalty per subscriber per annum. That the service as rendered at present in England by the companies must be fairly satisfactory is shown by the fact that the British Post Office telephone subscribers number all told only 1,300 for the whole United Kingdom!

We might adduce numerous additional facts to show the fallacy of the arguments of the advocates of municipal telephony but, leaving all other considerations aside, no one fully realizing what goes to constitute a good telephone service will, we think, place such a service at the mercy of municipal "politicians," at least until these have undergone a permanent change of heart.

PHOTOGRAPHY WITHOUT LIGHT.

THE announcement chronicled in our last issue that Prof. Rontgen had succeeded in photographing objects under the influence of electric radiation solely, has justly attracted worldwide attention, and this week we print additional confirmatory news of the photography of concealed objects by another experimenter, who has succeeded in obtaining pictures through an intervening medium consisting of aluminum plates an inch thick. While the discovery of this remarkable fact must command admiration, one can hardly suppress the thought that, now that it has been demonstrated, it seems so apparent it is strange it was not thought of before. The penetration of the Hertzian waves through various bodies has been the subject of a number of interesting studies which probably paved the way to the present discovery, but pending the receipt of more exact information the reported photography through a metal, aluminum, must be accepted with caution. At any rate the establishment of the fact that vacuum tube lighting makes it possible to photograph through opaque bodies opens up possibilities of the most far reaching consequence and cannot fail to have a direct application in most of the arts and sciences. Indeed it may become necessary to restrict the application of this discovery by legislative enactment. If what has reached us by cable be true, there can no longer exist any privacy in a man's own home, as any one armed with a vacuum tube outfit can obtain a full view photograph of any interior through a brick wall. Perhaps the house of the future will have a photograph-proof screen added to its walls and wide-awake inventors may get to work at once to devise such an one.

DEMAND FOR NIAGARA POWER.

IT is a pleasure to note how steadily the demand is growing for Niagara power, both on the spot and as far away as Buffalo. We illustrate and describe this week the calcium carbide factory just built at the Falls, and are glad to know that it soon have some more companions. Meantime, the industries already established are increasing their demands, and the Pittsburgh Reduction Co. making aluminum has just contracted the past week for 1,500 H. P. more from the big power house. The application of the power to the Niagara-Buffalo trolley road and to 12 miles of the Erie Canal with Mr. Lamb's scientific and successful system is far advanced, but this is not all, as apparatus is now being installed in Buffalo itself of such a nature as to be able to receive the Niagara current as soon as it can be delivered. Preparatory work on the pole line is being actively prosecuted, now that the contract has been closed with the city, and the present year will see a great deal accomplished in carrying out the plans of the courageous and farsighted backers of the great enterprise.

SUCCESS OF ELECTRIC CAR HEATING.

THE recent cold spells, so early in the season and so extreme in their severity, have done good work in proving the success and desirability of electric car heating. Where electricity has not been available, the managers of many roads have simply not tried to deal with the problem. The cable cars of the Metropolitan road in New York, for example, were run unheated and the passengers were often forced to leave them by reason of their unbearably low temperature. The New York Elevated road also, when the steam was needed for the locomotives, let its cars go cold, much to the disgust and suffering of the patrons of the road. But where the electric heaters were available, it was easy to maintain a comfortable degree of warmth, and fares instead of being repelled were attracted, in spite of an arctic climate keeping people indoors who were under no necessity to go out. Reports from all parts of the country tend one way, the newspapers commend the system highly, and the manufacturers are correspondingly busy. Any method of heating a steet car to-day other than electrical, is poor policy, and managers of roads are evidently coming to that conclusion very rapidly.

EDWARD WESTON.

THE announcement which we made last week as to the intention of Mr. Edward Weston to enter again the larger field of general electrical manufacture is one that has naturally been received with much surprise and interest. Of late years Mr. Weston has made an international reputation for himself as a designer of beautiful and accurate instruments, but it was not easy to see why he should so utterly abandon the scenes of his earlier successes. His work in electro-deposition and plating, his efficient and finely regulating dynamos, his methods of distribution, his incandescent lamps including those with the tamidine filament—all attested his master hand. We are glad to welcome Mr. Weston back to electrical engineering, and can assure him that there is plenty of work awaiting his skill and genius.

The reports that Mr. Weston intends also to devote himself actively to electrical journalism are the sheerest absurdity. Mr. Weston is a creator, not a critic or historian, and it is needless to say that he is perfectly willing to leave the drudgery of newspaper work to those who, while they record his progress with satisfaction, will not dream that they too are inventors.

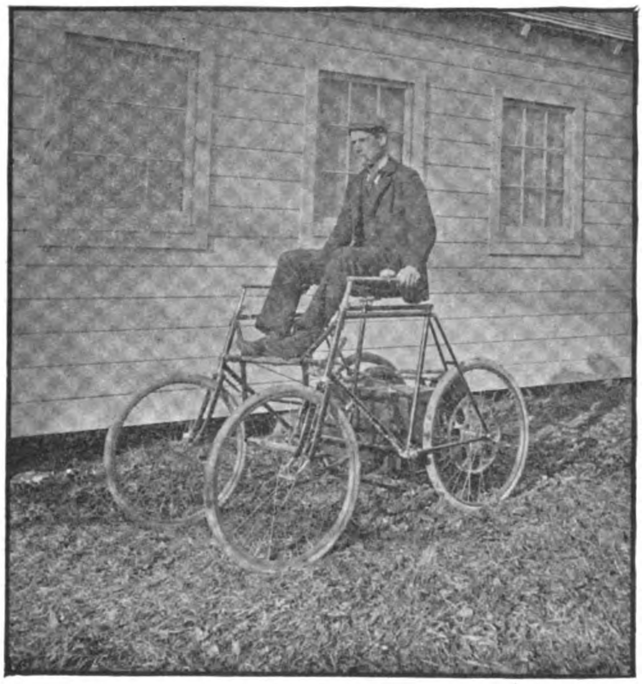
Electric Transportation.

THE RIKER ELECTRIC "MOTOR CYCLE."

OUR engraving represents the most recent attempt at adapting the electric motor to the propulsion of vehicles and the use of storage batteries for this purpose.

The motor cycle shown has been designed by Mr. A. L. Riker, president of the Riker Electric Motor Co., and is intended to be operated at a maximum speed of 12 miles an hour over ordinary roads, which speed it can maintain for 4 hours, thus giving at a travelling distance of 50 miles.

Two motors are employed, each of ½ H. P. and weighing



The Riker Electric Motor Cycle.

24 lbs. each. These are geared independently to the two rear wheels.

The storage batteries employed are of a specially light lead-zinc type and weigh 135 lbs. The total weight of the vehicle including everything is 310 lbs., which for its traveling radius is said to be the lightest motor-vehicle ever constructed. We understand that the Riker Company will shortly bring out electric cycles and carriages of all kinds.

LOW FARES IN BUFFALO.

Mayor Jewett has decided to approve the Buffalo Traction Company's franchise. The Company on its part formally agrees to grant certain concessions, the chief of which are these: 1. The reduction of the franchise from 66 to 50 years. 2. The sale of three tickets for ten cents. 3. Permission to the old company to use the tracks on the Elmwood avenue extension between Forest and Hertel avenues. 4. Free transfers. The franchise is to be signed and these provisions to be inserted hereafter by mutual agreement.

PRICE PAID BY THE NEW HAVEN FOR THE MERIDEN ELECTRIC SYSTEM.

It is ascertained positively from an official source that the New Haven Railroad Company, in acquiring control of the Meriden Electric Railroad system, paid $20 a share for 9,850 out of the 10,000 shares of stock, or $197,000, which represents the profits of the syndicate controlling the property, as nothing had been paid in on the stock. The New Haven Company also paid the floating debt of $70,000 and took at par $101,000 of the first mortgage 5 per cent. bonds of the Electric Company, which it holds in its treasury, including the bonds. The Meriden system thus cost the New Haven Company $368,000.

HOW THE LOWELL-LYNN 26-MILE TROLLEY WORKS.

The Lowell and Lynn line has been in operation a short time but the results already achieved justify the projectors in making the connection. Its especial value is that one can travel from Lynn to Lowell in about the same time that one can travel by the steam cars, and at just one-half of the fare. The cost from Lynn to Lowell is 40 cents each way, while the railroad fare is 80 cents each way. This means a great saving to a man with a family, who has business to transact in either city.

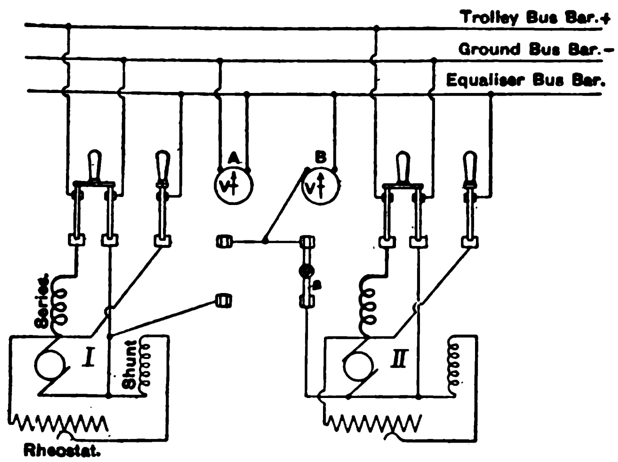
Recently one of Lynn's business men had occasion to make a trip to Lowell, and he was enabled to go there and back in the same time that it would take to go by steam railroad, and the cost was so much less that he was fairly delighted. Another incident of a similar nature is cited of a woman who left Lowell at 1.05 in the afternoon and arrived in Lynn at 3.45, transacted some business she had to do, spending an hour and returning on the car that leaves Lynn at 4.45.

The cars for Lowell leaves Lynn at 45 minutes past the hour, and it takes two hours and 45 minutes to make the trip. The cars run via the Lynnhurst line, so called, Wakefield, Reading, Wilmington, North Billerica, Billerica and Lowell.

HOW TO THROW ON A RAILWAY GENERATOR.

In the Dec. 27 issue of the London *Electrician*, Mr. H. Dubs, chief engineer of the Marseilles Tramways, describes a special switch combination for the purpose of preventing, as far as possible, a railway generator being thrown in circuit by careless operators before the equalizer switch has been closed.

The main double-pole switches and the equalizer switches are connected in the usual way. The voltmeter A is permanently connected with the negative bus bar and the equalizer bus bar, while the voltmeter, B, on which are taken the readings of the dynamos to be put in circuit, is connected with one pole to the equalizer bar, with the other pole to the upper terminals of as many voltmeter switches as there are dynamos in the station



Method of Throwing in Railway Generators.

All these voltmeter switches have only one common removable connection bar, *a*, fitted with an insulated handle.

This bar, or knife, is put into the voltmeter contacts of the dynamo to be put in circuit, but, as the voltmeter circuit B is then not yet closed, the operator, in order to take any readings on the instrument, has to close the equalizer switch II. By this simple device there is little chance of the operator forgetting to close the equalizer switch before putting the generator in circuit by means of the main switch.

As there is only one connection knife for all the voltmeter switches, the above device prevents, too, the short-circuiting of generators through these switches, which are generally very dangerous when of the double-pole type.

PROSPERITY OF THE NORTH CHICAGO LINES.

At a meeting of the directors of the North Chicago Street Railway Co. on Dec. 28, an extra dividend of 20 per cent. upon the $5,500,000 capital stock of the Company was declared. Ten per cent. of this, or $550,000, will be given as a stock bonus, and 10 per cent. in 6 per cent. debentures of the Company. The directors also voted an increase of $550,000 in the capital stock of the Company, for which stockholders will be allowed to subscribe pro rata at par. The stock sold that day on the Exchange at 308¼, and figured on a basis of 300 the stockholders get $3,000,000 in bonuses and rights.

THE TROLLEY AND THE ELEVATED IN BROOKLYN.

THE report of the Brooklyn Elevated Railroad for the year ending December 31, 1895, confirms the general surmise that the strike on the Brooklyn surface railroads was a most fortunate occurrence for the steam line. A deficit of $141,340 in operating results for 1894 became at the close of 1895 a surplus of $64,989; and the table of monthly returns shows how this surplus was made possible. The number of passengers carried, which in 1894 averaged 2,796,705 per month, rose in January, 1895, the strike month, to 4,271,994, held at 3,936,332 during February, and then gradually receded to the lowest figures for the year, 2,770,005 in August. The monthly average of passengers carried in 1895 was 3,338,963. Net earnings also showed a marked increase. Averaging in 1894 about $56,000 per month, they rose in January, 1895, to $109,010, though the monthly average for the year was only about $76,000. The months of April and May, 1894, showed the only monthly surplus earnings of the year. From a deficit of $11,424 for the closing month of 1894, the returns show a sudden transition, indicating a surplus in January, 1895, of $39,205. Until July the surplus continues, although fast decreasing, and for the rest of the year, excepting October, a deficit is returned.

The number of passengers carried is given as follows: 1895, 40,067,555; 1894, 33,560,462; 1893, 35,882,508.

A computation based on these figures shows that the cost to the road for carrying each passenger in 1895 was $.0503; in 1894, $.0558; in 1893, $.0518, actual cost of transportation, excluding fixed charges, ranging in the meantime between two and one-half and three cents per passenger. Similar computations from returns of the Manhattan Elevated Railroad show that for the year ending September 30, 1895, the total cost, including interest and dividend charges for transporting each passenger was $.0538, an increase of $.0034 over the cost during 1894. The figures are instructive as to the cost of operation under steam power, and significant when compared with similar figures for trolley operation. Their bearing on the arguments of those who oppose the building of a rapid-transit road to be operated electrically are important.

President Ullman in his report bears testimony to this, and reveals the fact that his Company was back of the conspiracy to limit trolley car speeds. He says in part: "The year opened with gloomy prospects. . . . The main streets of Brooklyn were perverted from their ordinary uses into overland routes for the operation of 'lightning express' trolley cars. . . . Killing and maiming was the rule and not the exception of the day. Emigration from instead of immigration to Brooklyn was evidenced during all the year 1894. To meet the situation, the directors resolved to co-operate with the authorities for a readjustment of transit conditions, relegating to the elevated railroads rapid transit, for the benefit of long-distance riders, and to surface electric railroads slower transit, consistent with safety on the surface of the streets for local riders." This solicitude for the safety of the public bore fruit, as is evident from the report, which adds: "In the spring of 1895 the authorities recognized the necessity of regulating the speed of surface railroads in order to stop the wholesale slaughter of Brooklyn's citizens, and on May 1, 1895, a city ordinance limiting the speed of trolley cars to eight miles maximum per hour in the old twenty-eight wards of the city went into effect. It was observed by the trolley companies to about July 15, 1895, and during that time its results were manifest. The number of accidents decreased, and with it travel in Brooklyn increased, as was demonstrated by the larger earnings of the elevated railroads."

The report also denounces the four-cent fare proposition of the trolley roads, calling it a dodge to divert attention from violations of the speed ordinance.

ADVOCATING THE NEWARK, N. J., TROLLEY FREIGHT.

Elias S. Ward, president of the Newark and South Orange Electric Railroad Company has sent the following open letter to the Board of Works in relation to a trolley freight system :—

Gentlemen: As a citizen of Newark who may have its interests at heart, although president of a street railway company, I call upon you to exercise very careful judgment in the consideration of the ordinance relating to freight service on the trolley lines. At the present time several large companies, representing millions of dollars, are looking for locations for factories where the best railroad facilities can be acquired. To drive the capital away from Newark means that its working people are deprived of their chance for wages, and its stores of their opportunity for profit. Millions of dollars have been invested in the street railroads of Newark, which have been the principal cause of its increased population and prosperity. Newark has at the present time as good a street railway service as any city of its size in the world, and your Board and its citizens should give the railroad companies the credit they deserve. Our geographical position places us in the most advantageous situation for manufacturing of any city on the Atlantic Coast. Why should we not take advantage of such a condition? I myself know of a million-dollar enterprise which will be driven away by the ordinance if passed in its present state, and see no reason why your Board should not consult with those who are interested in great enterprises in order that the best results may be obtained. Pounding investors is not the way to increase the growth of a city. Look back five years, and see what we had then; co-operate with the enterprise of Newark and see what can be accomplished in the next five years. Prosperity can come only with broad ideas, and the general welfare will advance in proportion to the activity and courage of our own people.

ELECTRIC TRACTION ON THE BROOKLYN BRIDGE.

The question of substituting electricity on the Brooklyn Bridge cars in the place of the locomotives, which are at present used in switching the trains in both terminals, will soon come up for final settlement. The General Electric Company has been engaged in fitting up one of the regular bridge cars with motors and this will take the current through a trolley pole from an overhead wire, which is to be strung in the terminals. One of these cars is expected to be able to draw three other cars to and fro on the structure and switch the train at both ends of the bridge. The work of fitting up the experimental car will be completed shortly, and when the specially constructed trucks arrive from Chicago and are attached to the car, the experiment will be tried. If the motors work successfully, it is the intention of the bridge management to equip a number of cars in a similar fashion, and, after doing away entirely with the locomotives, to use them in switching trains from the incoming to the outgoing tracks.

MUNICIPAL STREET CARS FOR PHILADELPHIA.

Resolutions were adopted on Dec. 26 by the Citizens' Committee of Twenty-one urging the Select and Common Councils to take such action as will most speedily result in vesting ownership of street railways in the city so that the city may lease them to the highest and best bidders under proper conditions and restrictions.

MORE STREET RAILWAYS FOR NEW YORK CITY.

The Empire City Traction Company has been incorporated to build and operate a street surface railway three and a quarter miles in length in New York City. The termini of the road are Hudson River and West One Hundred and Forty-fifth street; Harlem River and West One Hundred and Forty-fifth street; Hudson River and West Ninety-sixth street; East River and East Ninety-ninth street. The capital stock is $100,000, and the directors are: H. L. Scheuerman, F. H. Knight, E. M. Johnson, B. F. Defrece, F. W. Elder, M. J. Katz, H. W. Mayer, and Homer Scoville of New York, and Samuel Slater of Arlington, N. J.

REPORTS OF COMPANIES.

N. Y. EDISON ELEC. ILL. CO.

The Edison Electric Illuminating Company of New York has declared a quarterly dividend of 1½ per cent., payable Feb. 1. Coupons of the first consolidated mortgage bonds of this company due Jan. 1 will be paid at the office of the State Trust Company.

CONSOLIDATION OF LIGHTING INTERESTS AT HARTFORD, CONN.

NEGOTIATIONS have been pending for several weeks between the Hartford Electric Light Company, capital $350,000, and the Hartford Light and Power Company, capital $150,000, the two electric light companies for consolidation. It is reported that the arrangements have been completed by which the former company absorbs the latter.

A BALTIMORE EDISON CONSOLIDATION.

The Maryland Electric Co., and the International Telegraph District & Construction Co. have consolidated, forming the Edison Electric Illuminating Co., with a capital stock of $1,770,000. Alfred A. Glasier, is president; E. S. Webster, vice-president, and J. Frank Morrison, manager. The Maryland Electric Co.'s present plant of 1500 arc lights and 15,000 incandescent ights will be enlarged, and another plant of the same capacity will be built.

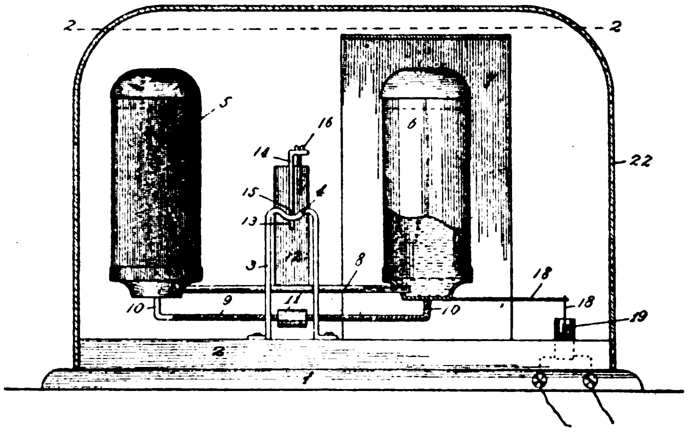
TOPEKA TELEPHONE TROUBLES.

C. O. Knowles has been appointed receiver for the Topeka Telephone & Electrical Co. by the district court. This is the outgrowth of a suit brought by the Harrison International Telephone and Cole's Construction Company of Chicago to collect $9,000 for telephones delivered to the local company. This suit is still pending, but E. A. Roseir, of St. Louis, who holds $15,000 of the company's bonds, became alarmed and asked for the receiver. The local management will not be changed, and the company makes the claim that the telephones sent from Chicago were rejected as unsatisfactory.

MISCELLANEOUS.

AN ELECTRIC SUNSHINE ANNUNCIATOR.

MOST meteorological observatories nowadays are equipped with sunshine recorders, and their indications are filed in the same manner as those of rain, temperature, etc. A form of automatic recorder for this purpose has been recently devised by Messrs. Hunt and Duenckel, of St. Louis, Mo., which we illustrate in the accompanying engraving. It consists of a pair of balanced bulbs filled with liquid, connected by a tube and suspended on a knife edge. One of the bulbs has a bright surface and is screened from the rays of the sun by a cover; while the other is blackened so as to absorb the heat rays of the sun. By adopting this construction it is evident that the heating of the blackened bulb causes the



ELECTRIC SUNSHINE ANNUNCIATOR.

expansion of the air in it and drives the liquid over into the screened bulb. This disturbs the equilibrium of the pair, which tips over and causes the arm carrying contact points to dip into mercury cups and to actuate an electric register. The cooling of the bright bulb allows the liquid to flow back and opens the electric circuit by bringing the arm out of contact with the mercury cups.

CONTEMPORARY ELECTRICAL SCIENCE.

THE old problem of contact electricity has found another investigator in C. Christiansen, who gives a first instalment of his results in the current number of *Wiedemann's Annalen*. The method used was that of drop electrodes of mercury, the differences of potential being measured between the reservoir and metallic plates dipping into the mercury caught. It appears to have been very difficult to obtain consistent results, but the general tendency of the experiments went to show that the oxygen of the air plays a very considerable part in the electric phenomena. Thus, drop electrodes of zinc amalgam and of pure mercury gave rise to different potentials in air, but the difference vanished when the drops passed through hydrogen.—Ludwig Silberstein evolved a law governing the dielectric constants of mixtures out of his inner consciousness, and then set himself to prove it experimentally. Given two perfect dielectrics which mix perfectly without contraction of volume, and given their specific inductive capacities, what will be the result of mixing them? The law in question is that the new specific inductive capacities will be the sum of the products of the volumes into the specific inductive capacities, divided by the total volume. Silverstein succeeded in finding only two such substances for his test experiment: benzol and phenylethylacetate. The maximum deviation from the formula was 4 per cent., and the average 1.7 per cent. So this process of mathematical law-making may be considered a success.—G. Meyer contributes a laborious investigation into the differences of potential between metals and liquids in connection with the theory of the capillary electrometer, which, by the way, appears to be increasing its sphere of usefulness. Helmholtz's charge-current theory of this instrument is undermined, and the author's conduction-current theory is strengthened by the results obtained.—Another highly interesting portion of Paalzow and Neesen's Paper on "The Passage of Electricity Through Gases" appears in the same number. Many curious facts were observed. On surrounding the discharge tube by different media, such as water, alcohol, or turpentine, the discharge is extinguished. This effect is not due to conduction, since the current is, if anything, enfeebled. On placing a point electrified by a Holtz machine near the tube, discharge was facilitated, and on moving the point all round the tube discharge took place even at atmospheric pressures.—K. Mack has continued his researches on the double refraction of electric rays. In the present paper he repeats the experiments with rays of various wave-lengths, proves that the two rays are propagated with different velocities in wood, and describes the preparation of artificial anisotropic media, in the shape of modified Hertz gratings, or—more simply—piles of newspapers!—*London Electrician*.

ORIGIN, OBJECT AND EFFECT OF SEC. 4887.

BY W. C. DODGE.

NOW that the Supreme Court, after years of effort, and the expenditure of many thousands of dollars, has finally construed Sec. 4887 of the Patent law, and as all are agreed that the law should be amended, it may be well to consider briefly the origin and object of the provision which limits the protection to an American citizen to the term of his shortest prior foreign patent.

As now construed, that section becomes a statute to punish the American inventor, if he refuses to give his invention free to all the rest of the world while compelling our own citizens to pay for its use: because, if he patents his invention in the United States alone, he can have a full term patent, for seventeen years; but if he tries to derive something from his invention abroad, to make foreign citizens pay for its use there the same as our own citizens do here, by patenting it abroad, then he is punished by being allowed at home only a portion of the full term, it being limited here by the life of his foreign patent which has the shortest term to run. If he does not patent it abroad, our competitors have it free from the start.

It will not do to say that he can prevent this by taking his patent here first, for two reasons; first, because in most foreign countries a valid patent cannot be had after a patent has issued here, or the invention has been made public there; and as our patent office sends the *Gazette* and copies of all our patents to nearly all foreign countries in exchange for their publications, the invention becomes public abroad almost immediately on the issue of the patent here. Second, because of the different manner in which the grant of patents is conducted at home and abroad.

Most foreign countries have no such system of examination as we have, and they grant the patent as a matter of course, on payment of the fee and certain proceedings had, say, in from six to nine months; whereas, in the United States no one can form any idea as to when the patent will issue, if at all, whether in three months or three years after the filing of the application. If our system were the same as theirs, and we could know that the patent would issue here in a certain definite time, then a party could so time his foreign applications as to have the patent issue here before, or at the same time as his foreign patents; but as matters are now conducted, that is impossible, for no one can tell how long his case may be held in the office here.

Again, a party here is liable to have his application put into interference with another, and that will delay the issue of the patent from one to three years, and in some cases they have been delayed by interferences ten to fourteen years.

True, patent attorneys try to avoid this difficulty by having foreign applications filed on the day the patent issues here, but as yet no one knows whether patents so issued abroad will be held valid or not, for so far as I have been able to learn, that question has not been passed upon by their courts. Moreover, a patent is liable to be stopped and put into interference in our patent office, even after it has been printed and published in the *Official Gazette*, and when it is too late to prevent the filing abroad; and thus while the patentee has taken every means in his power to prevent it, his foreign patent will issue first. In a case of my own, the Commissioner even went so far as to take my patent out of the post office after it had been signed, sealed and mailed to me, cancelled it on the official records of the patent office and put it into interference with an application filed the same day, a practice since declared unauthorized and illegal, by the Supreme Court.

Now this punishment of the American inventor is contrary to the spirit and intent of our patent system. It certainly could not have been the intention of Congress originally to thus punish him, and I think it perfectly clear that no one had any such idea at the time the limiting clause was first introduced into our patent law. A brief review of the several acts I think will make it clear that that limitation was designed to apply to foreigners who had already patented their inventions in their own countries, and not to American inventors at all.

Our first patent Act of 1790 authorized the grant of a patent to "any person," citizens and aliens alike. That was a very crude law, and existed less than three years. The Act of 1793, authorized the grant of a patent *to citizens of the United States only*.

Evidently Congress concluded that this Act of 1793 was not in accord with the object of the patent law as set forth in the Constitution, which was: "To promote the progress of Science and the useful Arts," for, of course, progress would be promoted by the introduction of inventions made abroad as well as by those made at home. Besides, it was impolitic to exclude foreign inventors, for at that time we had practically no manufactures, and it was therefore a matter of national importance to induce foreigners to bring hither their inventions that the nation might

have the benefit of them. Accordingly from that time on we find Congress letting down the bars to alien inventors step by step.

Section 1, of the Act of 1802, extended the right of a patent to aliens who at the time of filing their applications, had resided two years in the United States. The Act of 1832 provided that if the invention patented to an *alien* in the United States was not introduced into public use within one year from the issue of the patent, or was not in public use for a period of six months at any time after its introduction, or in case the alien patentee failed to perfect his citizenship within the earliest period within which he was entitled to perfect it, in each of such cases the patent should "cease, determine and become absolutely void without resort to any legal process to annul or cancel the same."

Section 8 of the Act of 1836, provided that "nothing in this Act contained shall be construed to deprive an original and true inventor of the right to a patent for his invention, by reason of his having previously taken out letters patent therefor in a foreign country, and the same being published at any time *within six months* next preceding the filing of his specification and drawings" in the United States.

Section 9 of this Act authorized the grant of a patent to "any person," citizen or alien, but made a distinction in the fee for the same. A citizen, or an alien who had resided in the United States two years and had made oath of his intention to become a citizen of the United States, was required to pay $30. Subjects of Great Britain were required to pay $500, and subjects of all other countries $300.

Section 15 of this Act also provided that the failure of an *alien* patentee for eighteen months to put his invention into public use in the United States and continue it on sale to the public, on reasonable terms, should be a bar to his recovery in a suit for infringement.

It will be observed that during all these years, no such condition as to working the invention, keeping it on sale on reasonable terms on pain of forfeiture, etc., was applied to the citizen inventor, but only to aliens. It was as though Congress had said to foreign inventors: We need your inventions, and we will grant to you the privilege of patenting your inventions in the United States on certain conditions different from those applied to our own citizens, but if you fail to put them into public use within a specified time your patent shall become void, or in case you sue on it you shall not recover anything for its infringement.

All this shows clearly that the object of Congress in thus modifying the law in behalf of alien inventors, was to induce them to bring hither and introduce into public use their inventions, and thereby help "promote the progress of science and useful arts"—in other words, the growth and prosperity of the country. In it all, there was no limitation of the rights of the citizen inventor, in any respect whatever.

In 1839 Congress went still further to induce alien inventors to bring here their inventions, for in Section 6 it provided that "no person shall be debarred from receiving a patent for any invention or discovery by reason of the same having been patented in a foreign country *more than six months* prior to his application in the United States, provided that the same shall not have been introduced into public and common use in the United States prior to such application; and provided also, that in all cases *every such patent shall be limited to the term of fourteen years from the date or publication of such foreign patent.*"

Here for the first time we find introduced the idea of a limitation of the term by the existence of a prior foreign patent. But in reference to whom was this limitation made? While the language used was such as to render the limitation capable of being applied to all patentees alike, both alien and citizen, a brief consideration of the circumstances existing at the time makes it clear to me that Congress had in view only foreign inventors.

It was for the foreign inventors that Congress was modifying the conditions. It said to them: No matter if your invention has been patented in your own country for more than six months, or any number of years less than a full term, we will still allow you to patent it here, but with the understanding that it shall expire here at the end of fourteen years from the date of your foreign patent, which was then the term of the American patent, and also that of the British patent, from which latter country nearly all our foreign applications came or were expected to come at that time. In fact, but very few countries had a term of more than fifteen years, or have at present.

Now at that time, few if any Americans took out patents abroad, while many more foreigners took patents here. I know of but two Americans who took patents abroad prior to 1839 (though there may have been more) while the record shows that sixty-eight foreigners took patents in the United States up to 1840, all but thirteen of whom were from England. It is a singular fact that these two Americans, Colt and Morse, both took out their foreign patents first. In Colt's case, it was simply because he happened to be abroad when he made his invention, it being patented in Great Britain in 1835, and in the United States in 1836.

Morse's case was different. He filed his application in the United States April 7, 1838, had it allowed and then placed in the secret archives as provided by law, while he went to France to patent it there, as otherwise he could not obtain a valid patent there. His French patent was dated August 20, 1838, while his United States patent was not issued until June 20, 1840; and it was this prior issue of his French patent on which his opponents relied to defeat his United States patent, in the case of O'Riley vs. Morse, 15th *Howard* 112. In that case the Supreme Court held that his patent was valid notwithstanding the issue of his French patent almost two years earlier; but the Court did not pass on the question as to whether the fact of his invention having been patented abroad first, would or would not limit the term of his United States patent.

It did say, however, in emphatic terms, that inasmuch as he had filed his application in the United States first, had paid the fee and complied with all the requirements of the statute, his United States patent was valid notwithstanding the prior issue of his French patent.

The same reasoning, it would seem, ought to apply to the other question, as to whether or not his United States patent would expire at the same time as his prior French patent; and to have determined that in such a case where the applicant had first filed his application in the United States the prior issue of a foreign patent should have no effect on the term of his home patent, any more than on its validity. But unfortunately, the Supreme Court in that case, as subsequently in the case of Bate Refrigerating Co. *vs.* Hammond & Co., decided in 1889 (9 S. C. *Reporter* 225), refused to pass on that point, though in this latter case that question was fully presented and argued by counsel employed for that special purpose, in order that those interested might know what the law was, and act accordingly. This was the more unfortunate because of the conflicting decisions of the lower courts on the meaning and effect of this Section 4887.

Of course this refusal of the Court was based upon its time-honored rule never to decide any question not absolutely necessary to dispose of the case at bar, a rule which it would seem greatly for the public interest to abolish or modify.

It is safe to say that in no other patent case has there ever been so many conflicting decisions involving such large interests as in those construing Section 4887; and nothing could better demonstrate the necessity for the establishment of a special court to try patent causes, by which some uniformity of decisions might be secured, and the rights in property which at most exists but for seventeen years, be speedily determined.

For an illustration of the conflicting decisions on this section the reader is referred to THE ELECTRICAL ENGINEER of April 2, 1890, p. 146, where three different decisions are printed in parallel columns, all written by the late Justice Blatchford, two while on the circuit, and the other while on the Supreme bench. As was well said, a comparison of those decisions is calculated to throw a shade of doubt upon the assertion of Blackstone that "the law is the perfection of human wisdom." Two of them held one way, and the other held exactly the opposite!

The reason for thus limiting the term of patents issued to foreigners who had previously patented the same invention abroad, is obvious. It was simply to prevent the American manufacturers and public from having to pay royalties for the use of those patents in the United States after the inventions had become free to their foreign competitors and the public abroad, by the expiration of the foreign patents for the same. That was the sole reason. It was wise legislation for the benefit of our own country, —first to induce aliens to introduce their inventions here, and second to so arrange that our people should not be at a disadvantage with those of other countries.

It must be remembered that at that time ours were truly "infant industries," our entire manufactured products as late as 1880 amounting to but $80,000,000, as against nine billions and over in 1890. We were struggling to build them up, and the Congresses of that day with true statesmenship, legislated in every way possible to that end.

At that time it never entered the mind of any one, that this limitation of the term applied to any except alien inventors, and to them only when they had first patented their invention abroad. As before stated, very few Americans took out foreign patents; and as was the universal custom everywhere, it was presumed, of course, that if they did, they would secure the patent at home first, just as the alien inventors did in their countries, or, at least, would file their applications at home first as Morse did.

Section 8 of the Act of 1842 still further opened the door to aliens by permitting them to take patents on designs in the United States, the same conditions applying to these as to patents for mechanical inventions. The Act of 1861 re-enacted the law in regard to alien inventors, and without any change in the fees.

In the revision of the United States Statutes in 1869, the language of the section was changed to read as follows:

"No person shall be debarred from receiving a patent for his invention or discovery by reason of his having first patented it in a foreign country; provided the same shall not have been introduced into public and common use in the United States prior to the application, and that the patent shall be limited to seventeen years from the date of the application of the foreign patent." This change to seventeen years was to make it correspond with the term of the United States patent as fixed by the Act of 1861.

The marginal note to this section of the revision reads as

follows: "Foreign patents may be patented;" and again, in the marginal note to Section 4887 in the copies of the law published by the Patent Office in 1885, and subsequently, was this:—"Patents for inventions previously patented abroad," may be patented, etc.

From the fact that all this had reference to "prior foreign patents," in connection with the general understanding that a prior foreign patent meant a patent granted to a foreigner in a foreign country first, the inference seems clear, that the limitation was designed to apply to such patents only, and not to those of our own citizens – certainly not to those citizens who filed their applications at home first. In this connection it should be remembered, also, that one of the committee of revision was the Hon. Geo. S. Boutwell, who was himself a prominent patent lawyer, and who would not be likely to use such terms without a clear understanding of the full import.

The final change in this Section occurred as follows. Soon after the completion of the revision, the Commissioner of Patents, Hon. S. S. Fisher, conceived the idea of amending the patent law. He took a copy of the revision as prepared by the Commission for the revision of the United States Statutes, and made in it such changes as he thought best,—cancelling with red ink such portions as were necessary, and, on blank leaves inserted in the pamphlet, wrote out the amendments or parts he wanted added. (One of the original copies thus prepared by him for the Committee on Patents, is still in my possession.)

In a consultation which I had with him at the time, he told me that his only idea of a change of the law relating to alien inventors was to place them on the same footing as American inventors, so far as the *fees* were concerned. He said: "We have put them on the same footing in the right to obtain patents and I think we should in regard to the fees. We have a large surplus in the Treasury, and therefore there is no longer any reason why we should exact from them these extra fees. In fact, I consider it very small business for a great Government like ours."

With that idea in his mind, the bill as prepared by him omitted these extra fees entirely; and the changes he made in Section 24 (now Section 4887) were to cancel the words "and common" before "use," and the words—"be limited to seventeen years from the date or publication of the foreign patent," and added in lieu of the latter, the words: "expire at the same time with the foreign patent, or if there be more than one, it shall expire at the same time with the one having the shortest term but shall in no case be in force more than seventeen years."

The only change intended to be effected by this amendment was to provide that where a foreign applicant had patented his invention in two or more foreign countries before applying in the United States—and which practice in recent years had become quite common,—his United States patent should expire with his shortest foreign patent.

This made the law definite and certain, whereas as it then stood, where a party had several foreign patents it was uncertain as to which of them should be used to fix the expiration of his United States patent. I know absolutely that he had no thought or intention of limiting the term of a patent to our own citizens who filed their applications in the United States first.

Nor was any such idea expressed by any one during the various hearings on the bill while before the House Committeee on patents. I was one of the committee of five appointed by the patent bar of Washington to look after the bill, and oppose certain features of it as drawn, more especially one which cut off the right of appeal from the decision of the Commissioner to the Court. We had several very full hearings, and I was present at various other times when the bill was being considered and discussed, and during all the time there was not a word of discussion or even a reference to that section or feature. We all understood that it would leave the law as it had always been construed, as applying the limitation to foreign inventors only.

As passed by Congress, it reads:—"No person shall be debarred from receiving a patent for his invention or discovery, nor shall any patent be declared invalid, by reason of its having been first patented or caused to be patented in a foreign country, unless the same has been introduced into public use in the United States for more than two years prior to the application. But every patent granted for an invention which has been previously patented in a foreign country shall be so limited as to expire at the same time with the foreign patent, or, if there be more than one, at the same time with the one having the shortest term, and in no case shall it be in force more than seventeen years."

Thus, while changing the phraseology somewhat and adding the provision, "nor shall any patent be declared invalid," it left the section substantially the same as prepared by Commissioner Fisher, and bearing in mind the fact that the prior foreign patent was, as it had always been understood to mean, a patent taken by a foreigner in a foreign country first, the conclusion seems irresistible, that neither the Committee nor Congress had any thought of applying the limitation to the citizen inventor, and certainly not to the citizen, who filed his application in the United States in the first instance. But unfortunately the Supreme Court felt compelled to construe the words literally, and when so construed it includes the citizen inventor as well as the foreign inventor.

That the law as thus construed works a great wrong to American inventors, without any corresponding benefit to our own people, all agree; and it is to be hoped that it will be changed at the coming session of Congress.

It is a sad commentary upon the condition of affairs, that with all the litigation and efforts made, twenty-five years elapsed after the enactment of the section before the public could ascertain what the law really was. In the meantime hundreds of thousands of dollars, if not millions, had been invested in business supposed to be protected by patents which the decision of the Supreme Court wiped out of existence, and which that Court could just as well have decided years before as not.

CONCENTRIC WIRING.[1]—I.

BY SAM. MAVOR.

CONSIDERING the importance of the subject of electric light wiring, it does not seem to have an adequate share of the attention of this Institution. This is the more unfortunate as the tendency now is to allow the business of wiring to drift out of the hands of experienced electricial engineers into the hands of the legion of plumbers, gasfitters, and others who, often with small claim to the title, write "Electrical Engineer" upon their signboards. It is inevitable that wiring shall fall more and more into the hands of tradesmen of this class. They will follow more or less closely the methods of their predecessors, and defects in existing practice will thus be widely propagated. This is a question which seriously affects the whole industry, and hence the importance of this Institution setting an example by aiming at and endeavoring to secure a high standard of excellence in wiring work. It is a characteristic of the business of electric light wiring that it is peculiarly liable to the risks attending bad workmanship. Internal wiring—that is, the laying of insulated conductors in grooved wood casings, the jointing of these conductors, and the fixing of switches, fuses, etc.—is a comparatively simple matter. Apart from the distribution of lights and arranging the circuits and their routes, it is not work which must necessarily be done by a highly trained and skilled tradesman. For such work as the mason's, the bricklayer's, the joiner's, cabinetmaker's, etc., a man requires the training of a long apprenticeship, which entitles him to the wages of a skilled craftsman; but the mere laying of wires already manufactured in grooved wood casings erected by a joiner, and fixing ready-made switches on bases also prepared by the joiner, do not require the serving of a long and laborious apprenticeship. On the contrary, any man who can use his hands may, with very short experience, learn to joint wires and fix switches, and then call himself a wireman. The inevitable result is that such laborer can, and always will, be cheaply purchased. Much wiring work is really done by irresponsible amateurs of this kind, who are ignorant of the consequences which might result from their carelessness and lack of experience.

A further reason why electric light wiring is often not carried out by first-class labor lies in the intermittent nature of the employment. There are certain seasons of the year when the wiring contractor has little of such work, and must then discharge men. Indeed, wiremen are many times taken on at the beginning of a job and paid off at the end of it. Workmen of skill and intelligence soon find this out, and they seek employment in branches of the business where their qualifications find a better and more steady market. We all know how demoralizing it is for men to be idle for months at a time, and how apt they are to drift into lazy and careless habits. The diagram showing the number of 8 C. P. lamps connected to the Glasgow Corporation mains during each month from January, 1898, till the present time illustrates the fluctuations in the demand for wiring. You cannot expect a man to have a thorough interest and sense of responsibility in his work who knows that he will be paid off at the completion of the job. As wiring jobs often last only a few weeks, the poor wireman may have been in the employment of half-a dozen masters in the course of a season, with intervals of enforced idleness. In the case of joiners and plumbers and kindred trades, when outside work is slack, the men may be employed in the shop at preparing material or in manufacturing; but not so with the wireman. The material is all already prepared for him by skilled hands—his business is only to erect it. The larger firms who have a variety of electrical work can find employment for the best of their wiremen in other branches when internal wiring is dull. But they, too, when business is brisk, have to fall back upon the shiftless creatures who often present themselves as "wiremen." The proportion of "improvers" and apprentices employed at wiring is very much larger than in any similar trade.

The business—if it may be called a business—of electric light wiring has thus several features peculiar to it making for unreliable workmanship, which, in the absence of competent supervision and careful inspection, lead to defective work and resulting fire risk.

The plumber's and the gasfitter's work are to a great extent

1. Paper read before the Institution of Electrical Engineers.

self-testing. If a water pipe leaks we see the water, and if a gas pipe leaks we usually smell the gas; but we have no sense—no physiological sense—to enable us to find hidden defects in our electric wiring. A building may be wired in the most dangerously slipshod style, yet the lamps may for years burn none the less brightly, until the latent faults have opportunity to discover themselves.

Insulation tests after the completion of the work, if in dry and well-seasoned buildings, are of little value. The insulation tests of the wiring of an old building might show results three or four times higher than the most stringent rules require, and yet there might be a score of dangerous defects only awaiting opportunity to develop. No tests can be applied for the detection of these defects after the work is completed and covered in. On the other hand, in a new and damp building the insulation might be far below the requirements of the rules, and yet be absolutely safe. The important thing is that the work shall be carried out in such a style that the insulation attained shall be permanent, and tend to increase, rather than decrease, with time. Wiring has to be carried out in situations so different, and must comply with conditions so varied, that it is impossible to formulate rules which can in all cases be adhered to. Modifications must be allowed to meet special requirements, and the extent of these must be left to a great extent to the discretion of the contractor. That such discretion ranges over very wide latitudes is indicated by the large discrepancies between the tenders of different contractors for the same wiring work. When the prices of experienced contractors estimating for wiring work to a carefully drawn-up specification vary as we know they do, it is not strange that inexperienced contractors tendering in the absence of a specification, and without the prospect of any supervision, should quote prices which would not purchase suitable materials alone. These are matters of primary importance to the fire insurance companies, and they are much too lax in looking to their interests in this regard. Bad work is being carried out every day, and the insurance companies are complacently taking the risk. Several offices have issued wiring rules, and it is a very good thing for them to have rules; but what is the use of rules if they are not enforced? At present they are really only recommendations, and anyone who is so inclined may evade or ignore them. It is common knowledge that this is constantly done.

The present procedure of the insurance companies is most ingenuous. They send a schedule to the contractor who is carrying out the work—or, rather, who has done the work, for it generally arrives after the job is completed—and they then request the contractor to oblige them by giving replies to a list of questions. They receive the document filled up by the contractor, who has no responsibility beyond a moral one, and file it away, and presumably are satisfied that the thing is all right. They thereby exhibit a trust in human nature very flattering to the wiring contractor, but of the wisdom of which some of us may have our doubts. Until the insurance companies have organized a thorough system of inspection they will not have taken the steps necessary for their own protection. It seems to me that in every considerable town there ought to be a permanent official (in the pay of the fire offices collectively) whose duty it would be to inspect all electric light wiring while in course of erection, and to ruthlessly condemn defective workmanship or material. If such a staff of well-chosen, reliable and sufficiently well-paid inspectors were scattered over the country, they would soon put a stop to jerry work. The moral influence of their presence in the town would be a wholesome check upon the cheap-jack. The cost when spread over all the companies would be trifling, and would be amply repaid by the reduction of fire risk. The insurance companies already have one man in their collective employment in each of several of the larger cities. This man is an *attaché* of the Salvage Corps, and his duties are confined to the warehouse district. His functions are to familiarize himself with the positions of main switches, fuses, and cables, &c., in the warehouses with a view to his being of service to the Fire Brigade in case of emergency.

Before leaving this subject it may be noted that Lloyd's Register of Shipping some years ago issued a set of recommendations for the guidance of shipbuilders and owners in fitting electric light on their vessels; but, as they took no steps to ensure that effect was given to their suggestions, these remained a dead letter. The large number of electric fires on board ship during recent years, chiefly due to inferior work resulting from the practice of accepting the lowest tender, has impressed upon Lloyd's the imperative necessity for supervision. They have, therefore, issued a new set of rules, and they are now arranging for such a system of inspection as will ensure these rules being followed. The fire insurance companies would do well to profit by the dearly-bought experience of Lloyd's. If they do not, they will assuredly have to learn the lesson at their own expense. Although the insurance companies are primarily interested in this question of fire risk, the matter has a direct and important bearing upon the electric lighting industry. We must all recognize the desirableness of ensuring that wiring shall be carried out in a style which shall be fire-proof, electrically and mechanically good and durable, and shall not be offensive to the eye.

THE MORRIS-SALOM ELECTRIC CARRIAGE has been sold for shipment to Europe.

THE DUNN METHOD OF PREVENTING ACCIDENTS ON BROOKLYN BRIDGE.

Mr. Elias B. Dunn, head of the New York Weather Bureau, has devised a system of electrical signals for the purpose of preventing rear-end collisions on railroads. The recent accident on the Brooklyn Bridge suggested the device, and Mr. Dunn's plan is now in the hands of the board of trustees of the bridge. It is Mr. Dunn's plan to divide the bridge into eight sections, four on each side. A series of wires or a wire cable containing the necessary number of wires is run along the poles or uprights of the bridge and connected with the train despatcher's office at both ends, New York and Brooklyn. A box containing a switch and push buttons is placed on each or as many uprights as may be found necessary. In case of a stop for any cause or any accident, or when for any reason a train cannot leave on schedule time, the brakeman reaches out to the nearest pole-box, turns on the switch which lights up a line of red signal-lights, also placed on the poles or uprights, over the rear section. This notifies the train following that the track ahead is not clear. The brakeman on the second train repeats the operation on his section, which sets the signal on that section back of him, and thus the third train would be brought to a stop, the fourth, fifth, and succeeding trains being notified and stopped in the same manner. As soon as the first train is ready to resume its journey, the brakeman reaches out and turns the switch back to its original position, and in so doing extinguishes the lights back of him, which indicate to the train behind that the road ahead is clear. All the other section lights are extinguished in the same way around the bridge, and the road is clear. The plan is said to meet with the approval of several of the trustees, and may come up for consideration at the next meeting of the board.

DATA ON THE NEW YORK FIRE ALARM SERVICE.

Mayor Strong in his new year annual message reports as follows:—The records of the fire-alarm telegraph service show the following:

The entire number of street boxes is	880
In public schools	181
In city institutions	27
Making	1,088
Street boxes connected with underground system	497
Buildings connected with underground system	60
Public schools connected with underground system	30
Hospitals connected with underground system	5
Total	592

There are now in the subways 108¼ miles of cables, aggregating 964 miles of conductors; 26¼ miles of underground subsidiary ducts have been constructed by the department. It is important that the work of putting electrical conductors under ground should be continued, together with the finishing of the larger part of the uncompleted portion of the city south of One Hundred and Thirty-seventh Street.

The new Bureau of Electrical Appliances, having the enforcement of the law regarding the installation of electrical plants within buildings of the city, has been put into operation and systematized, and the work of inspection is being carried out, from which it is expected much good will come in preventing fires caused by poor workmanship in the installation of electrical appliances, which has been a great menace to life and property.

Concessions of an important character have been made whereby citizens may have auxiliary fire-alarm boxes placed in buildings where direct connections are required. By Chapter 247 of the Laws of 1894, without extortionate charges to the owners, a small contribution to our Relief Fund is secured, and good results are confidently anticipated.

FALL RIVER'S MAYOR AGAINST A MUNICIPAL PLANT.

In his New Year's message, the Mayor of Fall River advocated the giving of an opportunity for competition in the matter of electric lighting of streets, and recommends that early in the year the question of new contracts be considered and determined. He does not think it advisable for the city to construct an electric light plant. It means a large expenditure and the constant changes made necessary by improvements in electric equipment would call for continued expenditures, which will be much better provided for by private enterprise and capital for at least an additional five years. Underground wires are urged at the earliest moment.

POSITIONS TO BE FILLED.

An open competitive civil-service examination for the positions of steam engineer, electrical engineer and dynamo tender in the state institutions at Albany, Brooklyn, Buffalo, and Syracuse, on February 1.

LETTERS TO THE EDITOR.

POSTPONEMENT OF THE MEETING CALLED TO STANDARDIZE ELECTRICAL CONSTRUCTION RULES.

THE Committee on Standard Rules for Electrical Construction and Operation, of the National Electric Light Association, issued a call several months ago inviting the American Institute of Electrical Engineers, the American Street Railway Association, the National Board of Fire Underwriters, the International Fire Chiefs' Association, the American Institute of Architects, the American Bell Telephone Co., the Western Union Telegraph Co., the Postal Telegraph Co., the General Electric Co., and the Westinghouse Electric Co., to co-operate with their committee in the forming of a joint committee to consider generally the subject of electrical rules, with a view of securing the promulgation and enforcement of one standard set of rules for electrical construction and operation, and which set of rules would meet with the hearty approval of the various allied interests above referred to, as well as the world at large.

A call for this joint meeting was issued for January 18, 1896. It was subsequently deemed desirable, in view of the short amount of time in which to secure the co-operation of the various interests invited, as well as to do certain preliminary work prior to said meeting, that the date of the meeting be postponed until March 18, 1896, and notice of this change in the date was sent to each of the parties.

In view of the fact that this proposed meeting has been commented upon quite extensively through the electrical press, will you kindly call attention to the postponement.

It also affords me pleasure to state that nearly all the parties, who have been invited to send a delegate to this joint meeting, have already accepted and have sent me notification of their acceptance and the appointment of their representative. This is most encouraging. I have no doubt that the others will also act in accord in this important matter.

WILLIAM J. HAMMER,
Chairman Com. N. E. L. A.

NEW YORK, Jan. 7, 1896.

THE STANDARD LAMP BASE: WHICH SHALL IT BE.

Of late much has been said in regard to the adoption of a standard base for incandescent lamps. Too much in favor of this important point cannot be said. Some recommend one base and some another as preferable, presenting in most cases excellent reasons for their opinion. Let us, however, view the whole situation and not hold a small object so close to our eyes as to shut out the rest of the world. The mission of this article is to reach if possible a satisfactory conclusion of the lamp base situation.

The three bases considered are Edison, Westinghouse and Thomson-Houston. The latter is accepted as a practical and satisfactory device, which it really is, but inasmuch as these bases cost the manufacturer from $7 to $8 per thousand in excess of the two former, it seems this fact alone should be sufficient to omit it from further consideration, realizing that the interests of the manufacturer and consumer are identical.

The cost of producing Edison and Westinghouse bases are about equal, thus excluding the argument which condemned the Thomson-Houston base. To the electrical trade, it occurs to the writer but one, and only one, conclusion is self evident. It is a fact that there are a very much larger number of Edison type sockets in use and demand than Westinghouse. To adopt the Edison base would necessitate less change (which is synonymous with economy) than the adoption of any other. Other points of superiority in these two bases are so evenly divided, no objection can be raised from a mechanical standpoint to standardizing either. So it seems in conclusion, that the most practical and advisable plan is to at least consider the Edison base as the best adapted for a standard.

The advantages derived by manufacturers and supply houses would be immense and a complete stock under new conditions would be quite difficult enough to maintain, considering combinations of candle power, voltage, economy, finish and style, whereas under existing conditions it is impossible. After all, the execution of these arrangements rests alone with the consumer. The manufacturer, therefore, respectfully submits it to their judgment.

The fact, however, should not be lost sight of, that simplifying the method of producing and distributing is to lessen the cost of production.

OLIVER F. BRASTOW.

BOSTON, MASS.

THE AMERICAN SOCIETY OF CIVIL ENGINEERS hold its forty-third annual meeting here this week. Among the special places to be visited are the Crocker-Wheeler factory at Ampere and the United Electric Light & Power Co.'s new station in this city.

OBITUARY.

DR. J. W. ROGERS.

Dr. James Webb Rogers, who, as one of the chief promoters of the Pan-Electric Company, gained considerable notoriety, died recently at his residence in Maryland. He was born in North Carolina in 1822, was graduated from Princeton, studied law and subsequently theology. He was an Episcopal minister for twenty years. Later he became a Roman Catholic. The Pan Telephone syndicate scandal which involved so many prominent Democratic politicians during the first Cleveland administration was largely based on the Rogers "patents" and "inventions."

PERSONAL.

MR. W. L. MORGAN, who has been the assistant superintendent of the Beaver Valley Traction lines has gone to Sharon, Pa., where he is to take charge of the Sharon and Sharpsville Road.

MR. GEORGE M. KUEMMERLEIN has been appointed general superintendent of the Milwaukee Street Railway Co. and Mr. T. E. Mitten becomes his assistant.

MR. S. M. WHEELER has been appointed superintendent of the Jamestown Electric Light & Power Co. He is a Brush factory graduate of 15 years' experience.

MR. GEORGE TURNER has resigned his position as superintendent of the Marion, O., Electric Light and Power Co., and will now devote himself exclusively to the electric railway, with which he has also been associated.

MR. HORATIO A. FOSTER, the electrical engineer and mechanical engineering expert, has had so many engagements of late in Buffalo that he is compelled by the pressure of his work to establish himself in that city. He has opened offices at 18½ Swan Street, that city.

SOCIETY AND CLUB NOTES.

ALTERNATING CURRENTS AND ELECTRICAL RESONANCE.—DR. PUPIN BEFORE THE BROOKLYN INSTITUTE.

On Friday, Jan. 3, Prof. M. I. Pupin delivered a lecture on "Alternating Currents and Electrical Resonance" before the Brooklyn Institute of Arts and Sciences. The audience was large and evidently deeply interested in the subject of the lecture.

The lecturer reviewed briefly the reactions going on in an alternating current circuit and described the fundamental laws which govern these reactions, showing that they are formally the same as the laws governing the motion of an elastic body. Hence for every mechanical phenomenon there is an electromagnetic phenomenon resembling it in all its essential formal elements. This was illustrated by experiments on electrical resonance and long electric waves. Several of the experiments shown were never performed in public before and they form some of the results of investigations in which the lecturer had been engaged during last year, particularly the experiments on long electric waves. The wave shown in the lecture was about 800 miles long and was produced by an electromotive force of frequency about 600 periods per second.

The subject of resonance was illustrated by several interesting experiments; the most important among them were resonant analysis of complex harmonic currents and multiple telegraphy by resonance. Four messages were sent simultaneously and independently of each other over a line of 6,000 ohms. Resonant rise of potential was shown by vacuum tube discharges. There were 16 different tubes, showing 16 different discharges. In several of them the discharges were in the form of hollow vortex rings waving toward the extremities of the tube and also rotating at the same time about the direction of motion. A brief statement of the electromagnetic theory of light and the Hertzian experiments concluded the lecture which was very well received and highly commended by the local press.

BOSTON "POTENTIALS."

At the next meeting of the Electric Potentials of Boston, on Jan. 21, Mr. Addicks, engineer to the Bay State Gas Co. is to read a paper on Acetylene Gas, and in consequence of the universal public interest now being taken in this new illuminant all the prominent electricians and gas engineers throughout New England are expected to be present and take part in the discussion. At the following meeting the subject to be discussed will be the influence and result of recent legislation on electric light and power securities. The "Electric Potentials" is growing in popular favor and increasing in membership right along.

CHICAGO ELECTRICAL ASSOCIATION.

The Chicago Electrical Association held its third meeting for this season at 1737 Monadnock Building, January 3rd. The paper of the evening was by W. Clyde Jones on the "Protection of an Invention," and was a very concise and complete statement of facts regarding American patent laws and customs that cannot fail to be of interest to the numerous inventors in the electrical field. The discussion which followed was taken part in by W. R. Garton, Thos. G. Grier, S. B. Jamieson and others.

Following the paper the election of officers for the ensuing year was held and resulted in the election of W. Clyde Jones, patent attorney with Barton & Brown, president; S. G. McMeen, assistant engineer Central Union Telephone Company, Chicago, vice-president; J. R. Cravath, electrical editor *Street Railway Review*, secretary; F. S. Hickok, engineering department Western Electric Company, treasurer.

There has recently been a great increase in interest and membership of the Association, and it promises to take a prominent place among the local societies in the largest cities in the country. Electrical men around Chicago are cordially invited to attend.

HENRY ELECTRICAL CLUB.—MR. JOSEPH SACHS ON SWITCHBOARDS.

At the weekly meeting of the Henry Electrical Club, held on Jan. 10, Mr. Joseph Sachs lectured on the subject of "Switchboards." With the aid of lantern views and diagrams Mr. Sachs described the various forms of switchboards used in arc and incandescent lighting, and street railway work, explaining the distinctive features of each. He traced the evolution of switchboards from the days when any place in a station was thought good enough for switches, rheostats, etc., to the present time in which all such apparatus is mounted on panels of slate or marble. Among recent improvements was the shunt method of connecting ammeters, in which the instrument is actuated by a fraction of the total current. In that way it was possible to use one ammeter for several circuits. In switchboard design, he said, the most desirable points were arrangement of measuring instruments so that they might be readily seen; simplicity; few switch contacts and joints; and ease of access to all parts of the board.

He dwelt on the importance of low resistance connections and switch contacts. Loose screws and bad contacts meant just so much added to the coal bill. Because bus bars and switches were large it was a mistake to think their resistances negligible. Danger from short circuits could be obviated by proper arrangement of circuits and attention to insulation. Fire risks were reduced by the use of non-inflammable materials like slate and marble. The practice now was to construct all switchboards in that way.

The lecture on Jan. 17 will be delivered by Dr. Pupin on the subject, "Transformers."

TELEPHONE CONVIVIALITY IN NEW YORK.

The members of the Contract Department of the Metropolitan Telephone Company gave effect last week to a new practice in the conduct of the Department by celebrating their first annual dinner. The gathering was planned and carried out entirely by the members of the department, its chief, Mr. T. H. Mack, being a guest; and the results showed that they are as good hands at organizing a dinner-table circuit as they are at securing metallic circuit telephone contracts at the rate of several hundreds a month. Those who have any feeling of surprise at the remarkable growth of the Metropolitan system, which for the year 1895 attained an increase of 25 per cent. in number of stations connected, would have wondered no longer if they could have glanced around the private dining room of the Madison Avenue Hotel at the score and a half of intelligent active-looking young men who carry on the relations of the Metropolitan Company with the public in need of telephone service. The dinner was excellent and good fellowship was promptly established by the perusal of the name and menu cards which were couched in the form of an extremely witty parody of a telephone contract. Mr. U. N. Bethell and Mr. H. L. Webb shared with Mr. Mack the honor of being the Contract Department's guests for the evening and took occasion to compliment the assemblage on the fine showing it made individually and collectively, morally and physically, and on the admirable results of their negotiations among the New York public in so largely increasing the use and popularity of the telephone. After dinner an impromptu musical and dramatic entertainment was provided by the diners. The gathering was so successful as a whole and the pleasure of meeting out of office hours so thoroughly appreciated that it was unanimously felt that the dinner would have a long line of successors.

A largely attended dinner of a single department of a single telephone company is one of the sidelights that one occasionally gets on the magnitude of the telephone exchange industry—in which, by the way, New York leads.

LEGAL NOTES.

IMPORTANT DECISION ON TAXATION OF CONNECTICUT TROLLEY LINES.

The decision of the Connecticut Supreme Court in the New Britain trolley taxation case was handed down on Jan. 7. It is written by Judge Baldwin, and the other four judges of the court concur. The decision is regarded as mixed and ambiguous, counsel for the trolley companies, however, claiming that it is a partial victory for their side.

The court upholds the right of a municipality to exact compensation for damages by a trolley road, and says, in effect, that such compensation may take the form of a levy on gross receipts for that part of the road which is constructed after the municipal order is passed; but such tax does not apply to the gross receipts of a system of trolley roads already constructed. Counsel for the companies hold, however, that such compensation under the decision must be limited to actual and specific damages to be determined by equitable proceedings, and that the municipality cannot arbitrarily fix a tax under the guise of compensation.

The decision finds error in so much of the judgment appealed from as relates to the requirement of annual payments by the appellant of a percentage of its entire gross receipts and of annual returns of the amount of such receipts, and to the use of fenders and to the execution within a given period of a written acceptance of those other provisions, and a written agreement to fulfill them, and referring to the approval of a location on any part of any street which leaves the unused part of the highway of less than the width required by section 8 of the street-railway act of 1893. The rest of the judgment was affirmed.

The case was then remanded to Judge Fenn, to be amended in accordance with the decision.

The finding is regarded as a compromise of opinions in the court which has had many sessions on the subject, and points of the decision are almost certain to lead to further litigation.

The court holds that an express grant by the state of the right of a company to lay rails through certain specified streets is not dependent on the consent of the municipal authorities, who have, however, power to "modify" the plans of the company while not fundamentally altering them. Municipal authorities, for example, cannot compel the substitution of another motive power for electricity, but may require the substitution of a storage battery for the overhead trolley. The municipality can merely "modify," not change, essentials.

The court holds that any regulation of the municipality of New Britain must apply to new lines, not to lines which have been accepted under an old contract between the company and the municipality. At the same time it states that if the tax imposed upon the New Britain Company's gross receipts had been estimated merely with a view to a fair tax on the new lines, the tax would have been valid. But the tax, on the contrary, in the view of the court, seems to have been imposed with a view to compensation for repairing the streets through which the old lines run.

The right to impose fenders on street cars, the court says, belongs exclusively to the Railroad Commission of the state under a specific law.

The court passes the question of the additional servitude of trolleys on highways as entitling the abutting landowner to damages, on the ground that it is not relevant to the case, and also the question whether existing trolley lines may or may not be taxed if suit is raised in a different form from that of the New Britain case. On both these points there is a suggestion that a constitutional question may hereafter be raised.

A DETROIT DECISION AGAINST TELEPHONE SUBSCRIBERS' CONTRACTS.

A decision was handed down on Jan. 3, in Detroit, by Judge Carpenter, of the Wayne County Circuit Court on a petition by Henry C. Wisner, asking for a mandamus to compel the Bell Telephone Co. to place an instrument in his residence without his signing an objectionable contract, and also to have the court declare that the rate charged by the company was unreasonable.

In his opinion Judge Carpenter said that while the telephone company agreed, in Mr. Wisner's case, to allow him a telephone without signing a contract, the latter's refusal to accept the concession was justifiable, as he had already commenced proceedings for a judicial determination of the controversy, and was entitled to one. If a mandamus was issued in the case of Mr. Wisner upon the concession of the company, the court would thereby compel the granting of a privilege which may be rightfully denied to every other member of the community by the company.

"Respondent is engaged in a public business," said the court. "It has been permitted to occupy the streets of the city of Detroit and to furnish service of a public nature to the entire community. It can not, however, as can an individual engaged in a business of private concern, determine with whom, how or on what terms it will do its business. Organized to deal with the public, enjoy-

ing a public franchise, engaged in performing a duty of a public character, like railroad companies, express companies and telegraph companies, it owes such a duty to the public that some branch of the legislative department of the government may regulate its business and its charges. And in the absence of such regulations, it can not insist upon unreasonable conditions nor exact unreasonable charges. A remedy by mandamus is the appropriate one.

"We do not think respondent had a right to insist that relator should rent a telephone for more than a year, if he pays all the expense of putting it in and taking it out and reasonable compensation for the service he receives.

"The proposed contract restricts the use of said telephone to relator and his employés. The language "he shall not extend this use to other individuals except his employés" clearly indicates that except in the contingency of relator's wife and children being his employés, they have no right to use his telephone. It is clearly unreasonable to compel relator to procure several telephones to perform the service which can be performed by one.

"This provision is, therefore, in our judgment, unreasonable. The proposed special contract provides that the telephone shall "not be used for calling messengers except from the lessor (respondent) or performing any other service in competition with services which the lessor (respondent) may undertake to perform." It would clearly be as just and reasonable to require relator to order all his groceries or all his shoes from respondent.

"There is, in our judgment, both a practical and a constitutional objection to our making a determination. The court cannot say that a rate which to-day is reasonable will in six months from to-day be reasonable. The character of the service rendered, new inventions, a change in the rate of wages, or in the rate of interest, will affect the reasonableness of the rate. It is, too, the province of the legislative department of the government to fix rates which shall govern the future business of respondent and those engaged in similar undertakings.

"It is the province of the judicial department of the government to determine what shall be charged for services that have been rendered. If we should attempt to determine to-day what relator should pay respondent for telephonic service for the next year, it would be within the province of the legislative department of the government to establish a different rate, and thereby overrule our decision.

"Our inability to determine reasonable rates for the future can not, however, deprive us of power to determine this controversy. It is not disposed of until the compensation to be paid for the service compelled to be furnished is determined. Justice can be done both parties by issuing a mandamus and determining, after the service is rendered, by an investigation in this proceeding, what is a reasonable compensation. A mandamus, therefore, should issue, requiring the respondent to furnish relator telephonic services without requiring him to execute the proposed special contract. A reasonable compensation must be paid for this service. If the parties hereto cannot agree, either may apply to this court at the end of every three months, or at any other time that relator discontinues the use of his telephone, to determine what shall be paid for the service which at that time respondent has furnished relator by virtue of this order."

All the Wayne circuit judges concurred in the decision.

VAN DEPOELE UNDERRUNNING TROLLEY—A REHEARING AND AN INJUNCTION DENIED.

In the United States Circuit Court at New Haven on Jan. 11, Judge Townsend has refused a rehearing of the under-running trolley case of the Thomson-Houston Electric Company against the Winchester Avenue Railroad Company. He denied an injunction against the Westinghouse Company, as it did not appear as a party to the suit.

JUDGE COXE'S TROLLEY SWITCH DECISION PARTLY REVERSED.

In the suit of the Thomson-Houston Electric Co. vs. the Elmira and Horseheads Railway Co., involving the trolley overhead switch patent of Van Depoele, the Circuit Court of Appeals has rendered a decision partly reversing that of Judge Coxe which sustained the patent. The new decision, however, is alleged to invalidate three of the minor claims and to leave the main broad claims in full force.

NEWSPAPER CABLE MESSAGES TO THE PRINCE OF WALES AND OTHERS WERE IN VIOLATION OF LAW.

State Department officials call attention, in connection with recent telegrams addressed to the Prince of Wales and others, to the following provision of the Revised Statutes taken from a law passed as long ago as Jan. 30, 1799, and still in full force and unrepealed:

"Section 5,335.—Every citizen of the United States, whether actually resident or abiding within the same, or in any foreign country, who, without the permission or authority of the Government, directly or indirectly commences or carries on any verbal correspondence or intercourse with any foreign Government, or any officer or agent thereof, with an intent to influence the measures or conduct of any foreign Government, or of any officer or agent thereof, in relation to any disputes or controversies with the United States, or to defeat the measures of the Government of the United States; and every person being a citizen of, or resident within, the United States, and not duly authorized, who counsels, advises, or assists in any such correspondence, with such intent, shall be punished by a fine of not more than $5,000 and by imprisonment during a term not less than six months, nor more than three years; but nothing in this section shall be construed to abridge the right of a citizen to apply, himself or his agent, to any foreign Government or the agents thereof for redress of any injury which he may have sustained from such Government, or any of its agents or subjects."

The subject of the cable messages sent by the *New York World* to the Prince of Wales, Duke of York and other eminent persons in England, in regard to the Venezuelan boundary dispute, was brought up in Congress last week, with special reference to the above clause; but the conclusion reached was that good rather than harm had been done in promptly eliciting friendly sentiments, and the matter was dropped without any action being taken.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS ISSUED DEC. 31, 1895.

Accumulators:—

Electric Battery, D. S. Williams, Philadelphia, Pa., 552,218. Filed July 19, 1895.

A storage battery involving novel construction and combination of the supports for the positive and negative discs of active material.

Electrical Battery, D. S. Williams, Philadelphia, Pa., 552,219. Filed Aug. 23, 1895.

A storage cell in which a single positive electrode is employed in connection with a large number of separate blocks forming a negative electrode.

Electric Battery, D. S. Williams, Philadelphia, Pa., 552,220. Filed Aug. 23, 1895.

The individual cells are combined in a single receptacle so as to give a high voltage.

Secondary Battery, A. S. Krotz and W. W. Spencer, Springfield, O., 552,222. Filed Jan. 31, 1895.

The active material is retained within sheets of porous material.

Secondary Battery, C. A. Faure, Paris, France, and F. King, London, Eng., 552,425. Filed March 6, 1895.

The active material is held against the plate by a sheet of silicated asbestos over which is placed a perforated envelope of ebonite or celluloid.

Alarms and Signals:—

Keyless Fire Alarm Telegraph Box, N. H. Suren, New York, N. Y., 552,153. Filed Mch. 8, 1895.

The local or box alarm will not sound until the handle has been turned far enough to trip the mechanism and set it in operation beyond the further control of the operator.

Electrical Railway Signaling Apparatus, H. J. Hovey, Evanston, Ill., 552,181. Filed Aug. 5, 1895.

Electric Signal for Railways, E. B. Cutten, New York, N. Y., 552,279. Filed Apl. 1, 1891.

The signals are given in the locomotive cab.

Electrical Railway Signaling System. T. B. Dixon, Henderson, Ky., 552,316. Filed July 10, 1894.

Conductors, Conduits and Insulators:—

Insulating Joint, E. P. Gleason, Brooklyn, N. Y., 552,363. Filed Dec. 27, 1894.

In an insulating coupling the combination of two tubular and flanged portions, the faces of said flanged portions being at substantially at right angles to the length of the tubular portions, a fastening device, consisting of a ring on the outside of the flanges and covering them and the plugs, the insulating material and plugs of insulating material extended through holes in the flanges.

Insulator, C. H. Snively, Mount Carmel, Pa., 552,501. Filed Mch. 20, 1895.

The combination with suitably supported insulator blocks, of means for simultaneously clamping the wire between the blocks and stretching the wire.

Dynamos and Motors:—

Synchronous Single Phase Motors, C. E. L. Brown, Baden, Switzerland, 552,318. Filed Feb. 6, 1893.

A motor consisting principally of two parts, a fixed winding bedded in iron directly connected to the mains, and a second rotating winding also bedded in iron and connected with two collectors. Of these one has a considerable number of segments while the other is simply a collector with an equal number of segments as the machine has poles.

Electric Motor, A. W. Smith, Washington, D. C., 552,337. Filed July 23, 1895.

An alternating motor involving a commutator and special winding.

Electro-Metallurgy:—

Electric Smelting Furnace, J. A. Vincent and J. E. Hewes, Philadelphia, Pa., 552,341. Filed July 18, 1895.

In an electric smelting furnace, the combination of the hearth, with a removable bottom constituting one of the electrodes, an adjustable electrode arranged above the bottom and movable vertically, and feeding devices at the upper part of the hearth or furnace for delivering the materials to be smelted into the hearth.

Galvanic Batteries:—

Depolariser for Primary Batteries and Method of Making Same, G. W. Thurnauer, Aurora, and M. M. Kohn, Chicago, Ill., 552,311. Filed Feb. 20, 1895.

As a new article of manufacture, a depolarizing plate consisting of copper oxide intermixed with copper chloride, the whole forming a compact solid mass.

Lamps and Appurtenances:—

Electric Arc Light, L. B. Marks, New York, 552,190. Filed Oct. 9, 1894.

An arc lamp having a transparent or translucent inclosure around the arc, provided with a small inlet for air and ducts for leading the air in a uniform direction relatively to the arc.

Electric Arc Incandescent Lamp, J. A. Mosher, Chicago, Ill., 552,498. Filed Sept. 23, 1895.

In a composite carbon for electric arc lamps all portions of which are combustible and electrically conductive, the combination with a core, of a body portion super-imposed thereon and being, relatively, as to the core, of high combustibility and low electric resistance.

Measurement :—

Electric Meter, J. R. Tucker & C. C. Hinckley, Aurora, Ill., 552,309. Filed Mch. 25, 1895.
Consists in connecting a recording device with an ammeter in such a manner that the length of time during which the recording device is operated in any given period will depend upon and vary with the current in the circuit.

Miscellaneous :—

Multipolar Electromagnet, W. P. Daniels, Cologne, Germany, 552,103. Filed Sept. 7, 1895.
A lifting magnet provided with a multiplicity of sliding pole pieces adapted to conform to uneven surfaces.
Electric Thermostat and Push Button, O. F. Woodward, Le Roy, N. Y., 552,166. Filed Dec. 29, 1893.
Combines in a single instrument an electric push button and thermostat, and in some instances a call-bell.
Apparatus for Transforming Alternating Currents Into Uni-Directional Currents, O. Pollak, Frankfort-on-the-Main, Germany, 552,260. Filed May 22, 1893.
A commutator for charging storage batteries from alternating circuits, constructed so as hold the electrical connections between the commutator segments and the commutator brushes open while the current impulses are below a predetermined potential but higher than zero, and closed while said impulses are above such potential.
Electrical Bicycle, O. Bolton, Jr., Canton, Ohio, 552,271. Filed Sept. 19, 1895.
The armature is mounted directly on the shaft of the rear wheel
Apparatus for Purifying Feed Water, S. G. Cabell, Washington, D. C., 552,412. Filed May 26, 1894.
Apparatus for electrolyzing the feed water.
Apparatus for Purifying Water by Galvanic Action, S. G. Cabell, Washington, D. C., 552,413. Filed Feb. 15, 1895.
Similar to above
Galvanic Feed Water Purifier, S. G. Cabell, Washington, D. C., 552,414. Filed Oct. 16, 1895.
Electric Gas Lighter, P. Meyer, Alameda, Cal., 552,384. Filed Sept. 20, 1895.
Adapted to burners of the Welsbach type.
Engine Stop, J. Brady, Brooklyn, N. Y., 552,462. Filed Feb. 14, 1895.
Improvement on Patent No. 506,229.

Railways and Appliances :—

Apparatus for Automatically Maintaining Current upon Moving Vehicles, H. B. Dey, Brooklyn, N. Y., 552,105. Filed May 20, 1895.
A storage battery energized from the motor dynamo and adapted to actuate the latter and energize the motor circuit upon a cessation of the main supply.
Electrical Rail-fish, V. Thelin, Geneva, Switzerland, 552,338. Filed Aug 1, 1895.
The rail bond carries a thimble which is inserted into a hole in the rail and expanded by a taper pin.
Motor-Suspension for Street-Cars, G. F. Card, Mansfield, O., 552,347. Filed Aug. 21, 1895.
The combination with a motor, of a frame having one end elastically supported upon the car truck, and the other end elastically from the car axle, and a pivotal connection of the motor and frame between the points of support of the frame.
Means for Operating Electric Railway Vehicles. E. G. W. C. Hoffman, Charlottenburg, Germany, 552,369. Filed Sept. 3, 1895.
Relates to the construction of a car controller.
Electric Railway, M. H. Smith, Halifax, Eng., 552,451. Filed Oct. 26, 1887.
In an electric railway system the combination with the main conductor, of the sectional surface bar conductors having extended poles pieces, and a magnetic switch comprising a pivoted lever carrying an armature for the pole pieces and carrying a contact piece for the main conductor.
Rail-Bond for Electric Railways, B. J. Jones, Chicago, Ill., 552,477. Filed Mch. 29, 1895.
The bond is of V-shape and occupies a vertical plane between the web and the fish plate.
Electrical Rail Bond, M. K. Kendall, Melrose, Mass., 552,479 Filed Aug. 12, 1895.
Consists in forming a series of cross slits in the bond, placing the bond with the centre of the cross-slits opposite bolt-holes in the web of the rail, and driving a bolt or pin into the bolt hole.

Regulation :—

Regulator for Dynamos, C. E. Scribner, Chicago, Ill., 552,397. Filed June 1, 1889.
Consists of means for altering the current connections of a multiple wound field magnet.
Regulator for Electrical Circuits, J. C. Mayrhofer, New York, 552,495. Filed July 5, 1895.
In an electric regulator, the combination with a resistance coil, of a series of commutator plates connected at intervals with said coil, circuit connections from the opposite ends of the coil independent of the commutator, and two contacts having circuit connections movable over the commutator, whereby different circuits may be regulated independently or together in the same or opposite directions.
Electric Lighting System, J. C. Mayrhofer, New York, 552,496. Filed July 5, 1895.
Object is to provide apparatus for the regulation and control of the electric lights in a theatre, whereby in a simple and effective manner the different colors and intensities of light desired can be secured.

Switches, Cut-Outs, etc.:—

Automatic Electric Switch, H. H. Blades, Detroit, Mich., 552,094 Filed Sept. 14, 1895.
A motor switch. Improvement on patentee's previous inventions.
Safety Device for Electric Circuits, P. H. D'Unger, Chicago, Ill., 552,239. Filed Sept. 16, 1895.
The circuit is opened by the explosion of a material fired by a spark from the secondary of an induction coil, the primary of which is placed in the main circuit.

Telephones :—

Electric Telephone, S. D. Field, Stockbridge, Mass., 552,173. Filed Aug 5, 1895.
Produces a transmitted circuit current somewhat analogous to that employed in cable "curb" signaling, in the case of the telephonic current, shortening or degrading the heavier pulsations created by heavy tones, and accentuating or magnifying the finer vibrations and harmonics. Employs device shown in patent No. 552,172.
Signaling and Lock Out Apparatus for Telephone Stations, J. D. Clarke, Chicago, Ill., 552,420. Filed April 5, 1895.
Details of construction.
Double Diaphragm Telephone Transmitter, D. Drawbaugh, Eberly's Mill, Pa., 552,469. Filed Feb. 23, 1895.
A microphone transmitter having two diaphragms which are acted upon simultaneously by the voice impulses.

Telegraphs :—

Electromagnetic Mechanism, S. D. Field, Stockbridge, Mass., 552,172. Filed Aug. 5, 1895.
An adaptation of Houdin's compensating levers to avoid friction between the colliding surfaces in contact in an armature and magnet.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS ISSUED JAN. 7, 1896.

Alarms and Signals:—

Apparatus for Protecting Electrical Circuits, J. M. Oram, Dallas, Tex., 552,542 Filed June 4, 1895.
When one transmitter makes the alarm-circuit the second transmitter, if in unison, breaks said circuit, and vice versa, and any failure in substantially accurate correspondence of unison results in indicating such failure.
Phase Completing Device, J. F. Sibley, Clinton, Canada, 552,553. Filed Mch. 23, 1893.
The phase-completing device is locked and retained in position while the arm is withdrawn to complete its backward movement, and releasing devices actuated by the next forward movement of said arm an equal distance throw out the locking devices and release the phase-completing device.
Automatic Electric Alarm, T J. Stansel, Laredo, Tex., 552,733. Filed June 1, 1895.
An automatic hotel guest call.
Local Alarm Door for Signal Boxes, F. W. Cole, Newton, Mass., 552,746. Filed Mch. 9, 1895.
A local alarm is given before the fire alarm can be transmitted.
Electric Signal Tag, F. G. Pratt, Revere, Mass., 552,776. Filed Aug. 20, 1894.
An arrangement of relays and their circuits as to require the closing of the circuits in a certain definite predetermined order, before the signal circuit proper can be closed so as to clear the signal after it has been shifted to danger.
Automatic Electric Alarm, G. B. Williams, Texarkana, Tex., 552,803. Filed Apl. 8, 1895.
For use in connection with automatic sprinkler system.

Dynamos and Motors :—

Electric Motor, S. D. Field, Yonkers, N. Y., 552,521. Filed June 27, 1892.
The combination with the motor frame carrying the field magnets, the armature, and brushes mounted in fixed relations to the field magnets of a support for the motor frame whereby the motor frame may be partially rotated without changing the relations of the brushes to the line of commutation.
Electric Motor, G. L. Thomas, New York, 552,858. Filed Mch. 19, 1895.
Gas is produced under pressure by electrically heating a voltaic fluid in a closed vessel, which gas is caused to actuate a motor, whence it passes to a condenser, where it is reliquefied and returned to the generator.

Lamps and Appurtenances :—

Electric Arc Lamp, W. S. Bartholomew, Chicago, Ill., 552,874 Filed Sept. 23, 1895.
Relates to the construction of the frame of the lamp, and particularly to the manner of securing the carbon holders and of guiding the carbons.

Measurement :—

Electric Meter, W. H. McGrath, Fort Wayne, and J. M. Oram, Dallas, Tex., 552,540. Filed July 8, 1895.
A clock meter which registers the time the apparatus has been in operation.
Electric Gas Lighting Burner, J. E. Swendeman, Boston, Mass., 552,594. Filed June 7, 1895.
The wiper is brought below the fixed electrode after each ignition.

Miscellaneous :—

Valve Controlling Device, J. F. Batchelor, Brooklyn, N. Y., 552,811. Filed July 23, 1895.
In a valve controlling device, the combination with a main balance valve of an auxiliary valve having a valve stem carrying a perforated slide valve, and a disc valve adapted to simultaneously control the supply and exhaust pressure to one side of the main valve and means to operate said auxiliary valve.
Instrument for Treatment of Strictures by Electrolysis, J. A. Fort, Paris, France, 552,832. Filed Nov. 7. 1895.

Railways and Appliances :—

Electric Railway System, H. Brandenburg, Chicago, Ill., 552,604. Filed Oct. 5, 1894.
The live conductor is completely sealed and shielded from moisture and is in circuit with the trolley wire only at the point of contact between such wire and the trolley.
Trolley, B. Dale, Milwaukee, Wis., 552,631. Filed May 9, 1895.
Self adjusting bearing spindles of peculiar construction, whereby the wear will be automatically compensated for.
Conduit System for Electric Railways, C. A. Gaines, New York, 552,755. Filed May 1, 1894.
Details of construction.
Motor Vehicle for Single Rail Elevated Railways, Fritz B. Behr, London, England, 552,812. Filed Sept. 26, 1895.
The combination of the two axles of the two driving wheels, carried by a separate wheel frame and extending from such wheels to opposite sides of the carriage, two motor engines, means for transmitting the motion of the motor engines to the wheel axles, and further describing details of construction.

Regulation :—

Electric Circuit Controller, H. A. Gorn, New York, 552,756. Filed July 26, 1895.
An automatic switch for elevator motor control.

Switches, Cut-Outs, Etc :—

Electric Switch, S. Bergmann, New York, 552,574. Filed Apl. 23, 1895.
A compound revolvable ratchet device of insulating material, having two complete ratchet-faces lying in different general planes, each having alternate conductive and non-conductive portions.
Junction Fuse and Switch Box, W. F. Bossert, Utica, N. Y., 552,658. Filed Apl. 3, 1895.
Electric Cut-Out and Insulator, H. A. Wagner and F. Schwedtmann, St. Louis, Mo., 552,580. Filed Jan. 21, 1895.
For description see page 63 this issue.

Telegraphs :—

Printing Telegraph, J. E. Woodbridge, Duluth, Minn., 552,788. Filed Oct. 7, 1895.
Improvements on the inventor's previous patent No. 549,179.

Telephones:—

Telephone Switch, G. W. Coy, Milford, Conn., 552,516. Filed March 15, 1895.
All the necessary switching is done by means of the transmitting apparatus instead of being done as heretofore, by means of the receiver.
Telephone Transmitter, I. J. Kusel, St. Louis, Mo., 552,689. Filed April 29, 1895.
Details of construction.
Telephone Switch, G. W. Coy, Milford, Conn., 552,705. Filed April 5, 1895.
Same object as above.
Multiple Switchboard for Telephone Exchanges, C. E. Scribner, Chicago, Ill., 552,723. Filed March 5, 1892.
Object is to provide apparatus for indicating to the operator primary signals from a calling line; so constituted as to fail to respond to signals subsequent to the establishment of connection with the line, and to accomplish this without including contact-points in line circuits.
Multiple Switchboard System for Telephone Exchanges, C. E. Scribner, Chicago, Ill., 552,724. Filed Mch 17, 1893.
An electric annunciator provided with two independently pivoted armatures, one armature carrying a hook or detent adapted to engage with and retain the other armature, which serves as a drop or target, the armature carrying the hook being adapted to be operated by a less current than is required to operate and retain in position the armature which serves as a target.
Spring Jack for Telephone Switchboards, C. E. Scribner, Chicago, Ill., 552,725. Filed July 30, 1892.
Switchboard System for Telephone Exchanges, C. E. Scribner, Chicago, Ill., 552,726. Filed Apl. 26, 1893.
The annunciator is rendered irresponsive to signaling currents during the existence of a connection with its telephone line.
Annunciator for Telephone Switchboards, C. E. Scribner, Chicago, Ill., 552,727. Filed May 2, 1893.
Responds to signaling currents of rapidly alternating character, but remains inert to continuous currents.
Multiple Switchboard, C. E. Scribner, Chicago, Ill., 552,728. Filed June 1, 1889.
Relates to a busy test on single cord multiple switchboards.
Spring Jack Switch, C. E. Scribner, Chicago, Ill., 552,729. Filed May 9, 1893.
Telephone Circuit, C. E. Scribner, Chicago, Ill., 552,730. Filed June 16, 1893.
Two induction-coils whose primary helices are connected with the same microphone and whose secondary helices are connected in series in the line-circuit; the telephone receiver is in shunt with the secondary helix of one of the induction coils.
Telephone Circuit, Charles E. Scribner, Chicago, Ill., 552,730. Filed June 16, 1893.
In combination, a microphone included in a local battery circuit, two induction coils having their primary helices connected in circuit with the microphone, and their secondary helices in series in a telephone line, and a telephone receiver in shunt or parallel circuit with one of the secondary helices, the object being to avoid side tone.
Telephone Switchboard and Circuit, T. C. Wales, Jr., Boston, Mass., T. Spencer, Philadelphia, Pa., 552,734. Filed July 25, 1895.
Relates particularly to a test circuit in centralized battery systems.
Trunk Line for Telephone Exchanges, T. C. Wales, Jr., Boston, Mass., 552,735. Filed Aug 24, 1895.
Applicable particularly to those switching systems in which calls received at an annunciator-board, where all line annunciators are placed, are distributed by means of trunk lines to different operators at switchboards.
Telephone, N. L. Burchell, Washington, D. C., 552,816. Filed Oct. 29, 1895.
An electric lamp is automatically lighted by the same movement that raises the receiver and transmitter.
Telephone System, F. R. Colvin, New York, 552,833. Filed Feb. 2, 1895.
For coupling subscribers' circuits and permitting the central office operator to hear and converse with both connected subscribers without disturbing the relations of their circuits.
Telephony, F. R. Colvin, New York, 552,865. Filed Jan. 14, 1895.
For description see page 69 this issue.
Telephone Switch, G. W. Coy, Milford, Conn., 552,866. Filed April 1, 1895.
All the necessary switching is done by means of the transmitting apparatus instead of being done as heretofore by means of the receiver.
Desk Telephone Apparatus, G. W. Coy, Milford, Conn., 552,867. Filed Apl. 1, 1895.
Similar to above.

THE PLAGUE OF MODERN IMPROVEMENTS—IN ENGLAND.

MR. HARRY FURNISS delivered himself of the following indictment in the *London Times*:—

"My experience in the last few weeks of the modern inventions which are designed to facilitate business and to benefit the public generally is, I think, worth recording, as I seriously question if these wonderful inventions and the extra expense incurred by adopting them are not a mistake. The working of the telephone has become, of course, a farce, and the sooner the Government takes it up the better. Several large business houses have given it up, and London, which ought to be the most favored, is probably the most unfortunate city in the working of the telephone of any in the world. I have tried half-a-dozen times in one day to ring up different people on the telephone without succeeding in getting through, and have had to send notes by hand. The electric light is another disappointing 'improvement.' Recently it has, in my own experience, gone out four times in one week, and we have had to use candles and lamps. Then there is the District Messengers' wire, which I have in communication with my house. I ring up for a cab; no response. I ring up again; nothing comes. I send out for a cab, and am late to dinner. The next day a representative calls casually to inform us that we cannot use the wire for two or three days, as something has gone wrong. I am now trying the phonograph; but, although at present I have had more correspondence about it than I have had through it I live in hope that I may find it worth the three years' trial the Company asks one to sign for. Altogether, it is a question whether paying rental for all these things, and then having, through their failure, to go to greater expense, is absolutely advantageous, and whether the story of the driver of the old stage coach who, when railways were introduced, remarked to a passenger, 'Well, all I can say is that if a coach comes to grief—well, there you are; but if there is an accident on the railway, where are you?' might not be very well applied to those experiments in the advancement of science intended to facilitate our work and add to our comfort. The electric light kills our sight; the telephone destroys our temper; the district messenger call ruins our dinner; and, conjointly, they waste our time and deplete our purses."

TO CONTRACT FOR A HAWAIIAN CABLE.

SENATOR HALE has introduced a bill in the U. S. Senate authorizing the Postmaster-General to contract with the Pacific Cable Company for the construction of a telegraph cable between San Francisco and Honolulu, Hawaii. The United States is to pay the company annually a sum equal to 4 per cent. of the amount expended each year by the company. The contract is to continue for twenty years, and the line is to be completed by July 1, 1897. It is also stipulated that the Government may come into the ownership of the proposed line by paying the cost price for it with 5 per cent. added.

CAMBRIDGE, MASS., MUNICIPAL LIGHTING PLANT.

The passing in the Cambridge Common Council of the resolution taking the property of the Cambridge Electric Light Company for municipal use means that the question will go to the people for final action. The purchase of this plant means an expenditure of $500,000 on the part of the city. This amount will probably be raised by issuing bonds.

Mayor Bancroft's signature is all that is needed before the people vote upon it at a special election. The mayor has not yet decided whether to sign or not. Many prominent citizens are endeavoring to persuade him against it. Prof. Agassiz, the celebrated naturalist, a large property holder, has announced his resolve to sell out and move to Newport if a municipal plant is started.

NEW HOPE IN ELECTRIC LIGHTING AT BRAINERD, MINN.

The municipal electric light plant at Brainerd was a failure, and the people recently voted overwhelmingly in favor of selling it, in order that they might save taxes and get a good service. Articles of incorporation of the Brainerd Traction, Light and Power Company have now been filed in Chicago, the stockholders being C. N. Parker, of Brainerd; E. C. Gibson, of New York city; P. A. Gibson, of Erie, Pa.; Fred S. Parker and W. S. McClenahan, of Brainerd. The officers are: C. N. Parker, president; E. C. Gibson, vice president; P. A. Gibson, secretary and treasurer; Fred S. Parker, manager; H. D. Freglawny, assistant secretary and treasurer. The company will have experienced men on the ground to make estimates on improvements in the electric light plant and water power, and will at once begin active work. From $10,000 to $15,000 will be spent in improvements at the lighting station. The plants included in the deal are the Brainerd Electric Railway Company, Brainerd water power, the electric lighting plant, owned by the city, and the Brainerd telephone system. This means much for Brainerd, and no stone will be left unturned that will lend a helping hand to the success of the enterprise.

SUDDEN DEATH OF MARCUS MARX.

Mr. Marcus Marx, vice-president of the Drawbaugh Telephone & Telegraph Co., of New York city, died suddenly on Monday last in the lobby of the New York Times Building whither he had been carried from the sidewalk. Mr. Marx came to this country from Germany when young and engaged in the glove business in which he amassed a fortune. Of late years he had devoted his energies to the Drawburgh Company.

THE MANAGEMENT OF "ELECTRICITY."

Mr. B. E. Greene, editor of "Electricity," has retired from the management of that paper and hereafter, including this week's number, "Electricity" will be issued under the direction of Mr. Edward Weston, electrician of the Weston Electrical Instrument Company, of Newark, N. J., who has associated with him Mr. C. D. Shain, eastern agent of Siemens & Halske.—*New York News Bureau.*

WESTERN NOTES.

L. A. BAKER & Co., Elgin, Ill., have now in their employ Mr. H. L. Willis, formerly an electrical engineer for the C. & C. Electric Co., and are prepared to do all kinds of electrical work and repairs on dynamos and motors in addition to their other business.

WEST CHICAGO.—Specifications for digging the trenches and laying the underground conduit, and making manholes and setting the lamp poles for the electric wires of the plant for illuminating the West Chicago system of parks and boulevards are now being got ready, and it is expected that work on this will be commenced very shortly, and when completed, the West side will have as fine boulevards as those already on the North and South sides of the city.

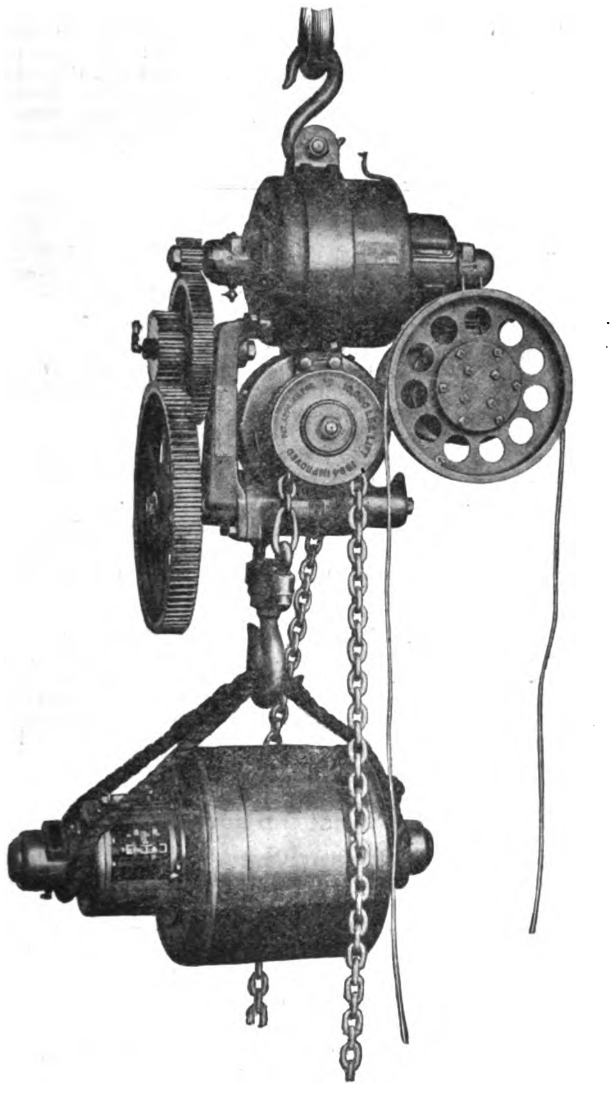
Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

STOREY MOTOR CHAIN HOIST.

ONE of the many new departures in the line of direct-connected apparatus is shown in the chain hoist here illustrated, which is a very useful piece of machinery especially in electric light and power stations, iron and steel foundries, factories, etc., and for handling heavy freight.

This is another of the ingenious products of the Storey Motor & Tool Co., and the type illustrated is of 10,000 pounds capacity. This hoist is operated by a 5 H. P. motor and will lift 10,000 pounds 5½ feet per minute and lighter loads proportionately faster. It will lower at the rate of 10 feet per minute. By means of the



STOREY MOTOR CHAIN HOIST.

reversing controlling box which comprises a part of the apparatus, the hoist will raise and lower anywhere within the above speeds at the will of the operator. The starting, stopping, regulating and reversing of the motor is controlled by the two ropes shown which are connected to a wheel on the reversing rheostat, which is automatic in its action, the current being cut off as soon as the rope is released.

WIRE WOUND COPPER PIPE FOR HIGH STEAM PRESSURES.

THE two 12-inch wire wound copper pipes, made by the Quintard Iron Works, and referred to in last week's issue, were made to suit the requirements of the New York Edison Illuminating Company in regard to strength. While the winding of copper pipe is no longer a real novelty, we believe the system of winding in the present case to be so. After the usual manufacture and test of the pipe, the latter is closely served, by a winding apparatus, with annealed drawn steel wire and fastened by special means at suitable distances apart.

The usual method of serving is to use wire rope (both copper and steel) and securing it with various styles of hitches which of course make a great number of kinks in the serving and thereby greatly reducing the strength of it. Among the advantages to be obtained from the use of wire winding for the pipe, may be mentioned, that the copper is not subjected to any more than the usual amount of working, harmful local heating of the copper is avoided, and the greatest strength of the steel wire is obtained without its strength being injured either by working or securing.

ELECTRA CARBONS USED BY THE NEW YORK EDISON CO.

The New York Edison Co., is noted for the care which it bestows on its equipment and the rigor with which it examines and tests all supplies before acceptance. An article adopted by them is therefore a safe guarantee of excellence and a much sought for distinction. The "Electra" Nürnberg, carbons, for which Hugo Reisinger, of New York, is agent, have been adopted by the New York Edison Co., after a severe test in which, we understand, they were pitted against a number of others. This ought to be a sufficient testimonial of their superior quality which will not be lost on central station managers.

CHICAGO CYCLE SHOW.

That the bicycle show which took place last week in Chicago was an immense success, must be apparent not only to any one of the many thousands who attended it, but also to the countless numbers of those who not being able to go there in person perused the Chicago papers at that time. It was computed by the most conservative people interested in this immense industry that upwards of $5,000,000 worth of business would be placed at the show during the week, while others of a more sanguine temperament estimated that it would amount to more than twice that sum. Tattersall's great show building on 16th street being found inadequate to the wants of the exhibitors, two floors of the neighboring Jonathan Clark building on State and 16th streets had to be taken in as an auxiliary.

There were some 200 exhibitors of bicycles and everything pertaining to this great and still growing business.

The decorations of the buildings and spaces were on a most elaborate scale, the furnishings of the booths being very rich and tasteful; and many of the electrical signs and devices were so handsome as to make the tout ensemble remind one of the days of the World's Fair.

It is estimated that the value of the exhibits amounted to upwards of $500,000. The total expenditure in lighting and decorating the buildings was $35,000 which did not include the decorations and lights used in the individual booths.

In the lighting 200 arc lamps and over 5000 incandescent lamps were used, and this part of the display attracted fully as much of the attention of the crowds that thronged the buildings as the bicycles which were on show. Among the exhibitors were several well known in the electrical business inclusive of the following: Adams & Westlake, Julius Andrae & Sons Co., Prentiss Tool & Supply Co., Garvin Machine Co., Lodge & Davis Machine Co., Newton Rubber Works, Cycle Electric Light Co., Independent Electric Co.

The Chas. E. Gregory Co., Illinois Electric Construction Co., and others supplied the lighting material for the booths.

A WRONG IMPRESSION.

It is generally supposed that the demand for weather-proof wire is limited after December first, but the Electric Appliance Company report that their sales are increasing, and if anything, are larger than during the fall months.

MONOCYCLIC GENERATORS AT ST. LOUIS.

The second direct-coupled 800 K. W. monocyclic generator built by the General Electric Company has been started successfully in the St. Louis station. This machine and its brother which has been operating for some time in that station, are the largest generators of their kind, so large indeed that it was impossible to assemble them at the works before shipment. They are now operating successfully incandescent lamps, arc lights and motors in the city of St. Louis.

NEW ENGLAND NOTES.

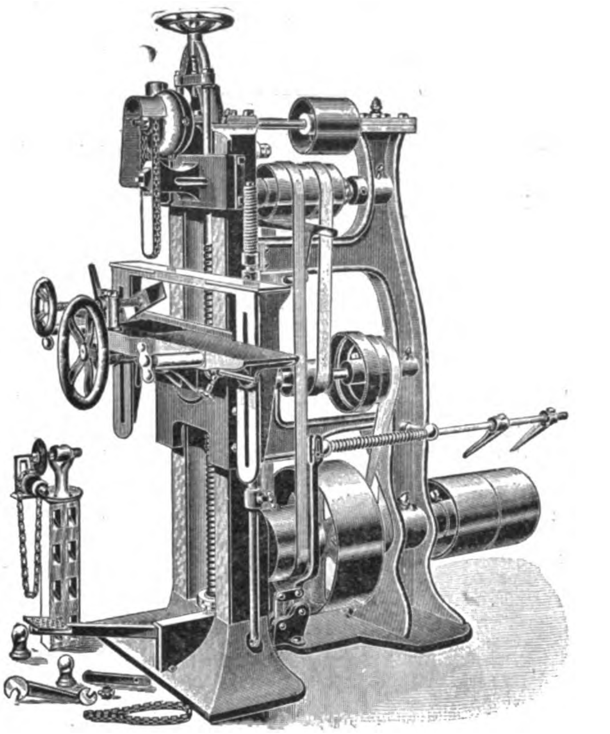
THE DIAMOND MACHINE Co., of Providence, R. I., has recently moved its department for the manufacture of leather covered wood polishing wheels into a new building, especially built and adapted to this purpose, thereby more than doubling the capacity for the manufacture of these goods. This move has been necessitated by the increased demand for wood wheels, recent orders having been booked for 500 wheels from one firm and 40 from another.

THE NEW BRITAIN MACHINE CO.'S CHAIN SAW MORTISER.

Perhaps one of the most important improvements in woodworking machinery introduced within the last decade is the chain saw mortiser, the patents for which are now controlled and the machine built by the New Britain Machine Co., of New Britain, Conn.

In this machine, one size of which is illustrated in the accompanying engraving, the cutting is performed by a steel chain, each link of which has a sharpened tooth so formed as to carry away its own chip, and is presented to the work a thousand times a minute, which illustrates the possibilities of the machine for rapid work. This chain, driven by a sprocket, travels over, and is guided by a chainbar having an anti-friction bearing at its lower end.

The table holding the work is fed automatically up towards the chain, the mortise, either "blind" or "through," is made at a single cut and the table rapidly descends to the starting point



New Britain Machine Co.'s Chain Saw Mortiser.

ready for another mortise so quickly as to almost limit the machine's output by the ability of the operator to supply it with work. Under ordinary circumstances, from 400 to 500 four panel doors can be put through in ten hours (each door having ten accurate, clean mortises,) and other work in proportion, depending on the size of mortise and hardness of stock.

The range of the No. 1 Standard Mortiser as at present constructed, is any mortise from $\frac{1}{16}$ to 1 inch in width, $1\frac{1}{4}$ to $3\frac{1}{2}$ inches in length, and up to $6\frac{1}{2}$ inches deep at a single cut, or up to 13 inches in depth by reversing the stock.

Our illustration represents the No. 2 Standard Mortiser which in size and capacity is a duplicate of No. 1 with the addition of a compound table, which is of great convenience in making very long mortises without unclamping the stock.

The New Britain Machine Co., also build the well-known Case engine which are admirably adapted to situations where space is limited. These engines are built in sizes from $2\frac{1}{2}$ to 25 H. P.

ADVERTISERS' HINTS.

Transformers of any voltage can be purchased of the General Electric Co.

The Standard Air-Brake Co. continues to discuss questions of practical importance to the street railway man.

Abendroth & Root Mfg. Co., are again advertising their improved water tube boilers. Their claims for these boilers have been substantiated under the most severe tests.

Roll Drop Commutator Bars is the topic of the Forest City Electric Co. who are pleased to furnish full particulars on request.

The Central Electric Co. remind their friends of their always up-to-date stock of incandescent light supplies. It includes every conceivable article for every style of lighting.

PHILADELPHIA NOTES.

Mr. Joseph Fritz, the electrician of the Francis Wilson Opera Co., playing in Philadelphia, shot himself through the heart on Jan. 8. He is said to have lost \$70,000 in speculation.

Camden, N. J.—It is claimed that \$400,000 has been improperly spent for lighting purposes by the City Council during the past eight years, in votes to the Camden Lighting & Heating Co.

The Falkenau Engineering Co., Ltd., have removed their offices to the suite 711 Reading Terminal Building and their stock room to the basement of the Reading Market. The excellent facilities of this building were recently described very fully in The Electrical Engineer, and the firm are now in good shape to handle any increase in their business, no matter how large.

CANADIAN NOTES.

Mr. R. Anderson, Ottawa, electrical engineer and contractor, reports having secured the following contracts: 700 light plant complete including street lights, for J. H. Francis, Pakenham, Ont.; 125 light plant, North American Graphite Co., Buckingham, P. Q.; 600 lights, J. D. McRae, Eganville, Ont., with 125 H. P. in electric motors; 150 lights at Union Station, Ottawa, for the Canadian Pacific Railway.

NEW YORK NOTES.

Speaking Tube Telephones.—The Metropolitan Telephone & Telegraph Co., 18 Cortlandt street, has issued a very interesting and instructive pamphlet on its "speaking tube telephones" for interior service of all kinds.

The Forest City Electric Company, of Cleveland, New York and Chicago, has recently issued a chart entitled "Divisions of Commutators" for the use of electrical engineers, designers of dynamos and repair men. This chart gives the degree and angle chord of bars in commutators of from 4 to 875 divisions. One of these charts will be mailed to those interested upon application to the nearest office. This data has been compiled by Mr. W. B. Cleveland, E. E., the Company's General Manager.

Eugene Munsell & Co., 218 Water Street, New York, with agencies in the principal cities, report an increased demand for solid sheet India and Amber mica, of which they make a specialty for electrical insulation. The Company import direct from the mines, and at all times carry the largest stock of mica to be found in this country. They have recently installed several new power presses, which gives them increased facilities for furnishing stamped solid sheet mica segments for all types of railway motors, and mica to any shape or pattern. Mr. Franklin Brooks, the junior member of the firm, is now making a tour around the world, and is spending considerable time at the mines in India, where the firm is largely interested.

NEW ENGLAND NOTES.

Mr. George E. Bliss has left the employ of the Malden Electric company and is now a member of the firm of Bliss & Pearson, dealers in electric supplies.

The Electric Railway Switch & Supply Co. has been formed at Saco, Me., to make switches and supplies, with \$100,000 capital stock, \$300 paid up. L. L. Davis, of Springfield, Mass., is president.

The Berlin Iron Bridge Co., of East Berlin, Conn., have just completed for the Windsor Co., of North Adams, Mass., a new fire-proof store house 70 ft. wide and 125 ft. long. The construction is composite, being iron and brick; the whole being fire-proof, no wood work being used. The floors are made of terra cotta.

The National India Rubber Co., of Bristol, R. I., have just closed a large contract for N. I. R. Cables; and their electrical department is exceedingly busy. They have completed extensive alterations and additions, and anticipate a good year's business. A new catalogue is in press and will be sent to their friends as soon as issued. They will also be glad to send a copy to anyone who will favor them with their address.

The Atlanta, Ga., Trolleys have to meet the novel competition of a "herdic" service at three cents. These little busses are already in use and seem to be popular.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Financial, Miscellaneous, etc., will be found in the advertising pages.***

THE

Electrical Engineer.

Vol. XXI. JANUARY 22, 1896. No. 403.

ELECTRIC LIGHTING.

PHOTOGRAPHING AND SEEING IN DARKNESS.

BY

G. d'Infreville

THE publication in the last two issues of THE ELECTRICAL ENGINEER of cable dispatches from abroad announcing the fact that photographs had been obtained of objects screened from the sensitive plate by opaque bodies, has justly created a sensation the world over.

This announcement makes it incumbent upon me,—though I do so with some reluctance,—to publish my claims to a process for secretly photographing and seeing objects at night or in darkness without the use of the well-known flash light. This process has engaged my attention for several years, and one of the reasons I have kept it almost exclusively to myself and to a few trusted friends is, that I am still engaged in research in view of useful additions to it. On the other hand the complete description of the theory and of its practical application is out of the question, as it would at once destroy most of its value commercially.

I will state, however, so as to not mislead anyone, that the photographing or seeing in darkness does not give the same result as in daylight when obtained by the present well-known means. Some parts do not seem to appear as well, some others seem to be more visible; some features which were entirely invisible in daylight seem to be curiously disclosed even in some cases when covered by other substances. But the resulting effect is likely to be found interesting or useful.

I consider the seeing in darkness of particular importance, as photographing could not replace it as well or at all in many cases. For instance, it is advantageous to follow with the eye all the movements of a torpedo boat so as to take at the right time and without any delay proper and effective measures, such as the aiming and firing of guns, to repulse the attack. This process for seeing at night without being seen might, I think, be used to protect coasts and harbors against hostile fleet with particular advantages impossible to obtain with the use of the well-known search light as the latter indicates to the enemy that it is observed.

I think it will be possible by said new process for a man-of-war to secretly inspect its surroundings or a coast, or for a fleet to organize a constant and effective secret night watch against torpedo boats or carry on an effective night bombardment. It would, I think, help on land a comparatively small body of soldiers during a night attack to overcome a more numerous one not thus equipped. In short, in time of war the possession of said process would, I think, give superiority to the army or navy over an enemy not similarly provided. I think that policemen, night watchmen and detectives may with it watch or photograph interesting people or objects during darkness without being noticed.

These examples will suffice and need not be extended here as the field of applications may develop great variety and importance. Electricity has not a little to do with my process, but I would rather not tell to what extent, for the present.

I may conclude by reminding the reader that many animals can see in darkness; the cat and others of the feline family, the owl, the bat and even the horse, to some extent, are examples of it. Man has already outdone animals in other respects. Why could he not do it also in this one?

In reply to the editorial remark that while it may be of advantage to society it might also have its inconvenience, I would say that the process to some extent bears its own remedy with it, which can only be explained by disclosing the process itself. Are the telescope, opera glass or photographic camera classified among dangerous objects to-day? At any rate, can the progress of science be arrested and does it not result in the end to the greatest benefit of society?

THE DONSHEA METHOD OF CHARGING THE FIELDS OF LARGE CENTRAL STATION DYNAMOS.

THERE are three methods of exciting the fields of dynamos known as "Self-Exciting," "Bus Exciting" and "Separate Exciting." The advantages and disadvantages of these several methods are as follows:

In "Self-Exciting" the field terminals are connected to the brushes. The advantage of this method is that the field gradually dies away as the dynamo is slowed down, and when the dynamo is stopped, the field has entirely disappeared, thus avoiding danger of a sudden discharge of the field which would probably pierce the insulation of the field winding or make a short circuit through the armature.

The disadvantages of this method are: first, the slowness with which the dynamo builds up its own field, the dynamo frequently running at full speed for a considerable length of time before it develops E. M. F. sufficient to be connected into the system; second, the possibility that the field may build up reversed. This may be caused by a sudden discharge of the field, by a short circuit, or even by proximity to another dynamo.

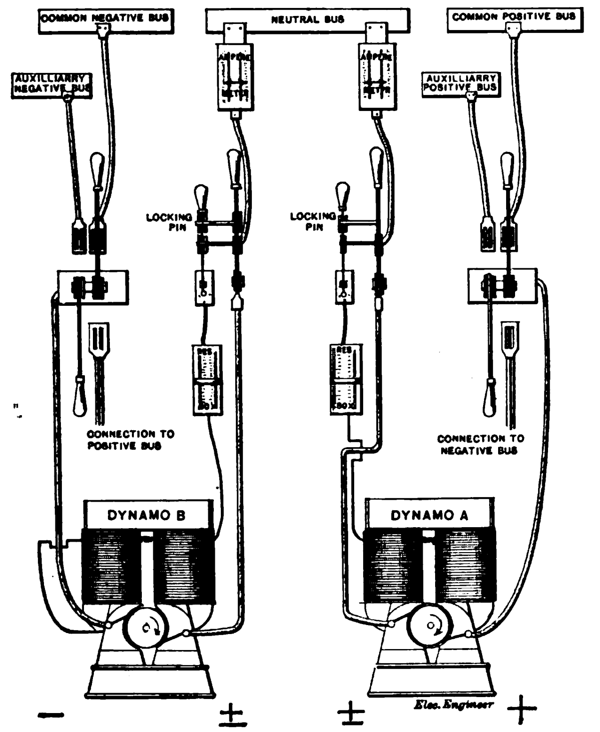
In "Bus Exciting" the fields are connected to the station mains or busses. The advantages of this method are: first, that the field is instantly made and the dynamo can be connected into the system as soon as it is up to speed; second, the polarity of the field is always the same, and hence cannot come up reversed. The disadvantage of this method is that the field is on although the dynamo may be shut down, and it is necessary to discharge it through a bank of lamps or other resistance by means of a field break switch. This method of discharge, although safe, might cause trouble were the bank of lamps disconnected or otherwise out of order.

In "Separate Exciting" the field circuit of each dynamo, or of all the dynamos, is connected to a special dynamo or other current producing device. This method possesses the same advantages and disadvantages as the "Bus Exciting" method does. It has the additional disadvan-

tage that the exciting dynamo or battery is small, and, therefore, weak and unreliable. An accident to it would cause the loss of as many dynamos as were being charged from it. To obviate the difficulties above enumerated with the three systems of field excitation, Mr. W. I. Donshea, of the New York Edison Company, has devised a method which is in use in the stations of that Company and has also been introduced in a number of Edison stations in other large cities.

In the Donshea method, one side of the field coil winding is connected to one of the brushes, while the other side of the winding is brought through the regulating resistance box to the blade of the field switch. As shown in the accompanying illustration, this blade is pivoted on the same axis as the blade of the main dynamo switch on the regulating switchboard, but not connected with it electrically.

When the blade of the field switch above referred to is closed it makes contact with clips connected to the neutral bus. The field circuit is then made from the neutral bus,



THE DONSHEA METHOD OF CHARGING DYNAMO FIELDS.

through the field switch, through the regulating resistance box, through the field coils and to the brush which is connected through a switch with the positive or negative bus, and the field is thus bus excited. When the dynamo is up to pressure, as indicated by the dynamo galvanometer, the main dynamo switch is closed. On the blade of this switch are mounted clips which engage into the blade of the field break switch and a pin or latch which is operated by a spring drops into a hole or slot on the blade of the field switch and securely locks the two blades together. Thus when the blade of the main dynamo switch is opened it brings the blade of the field switch with it, the two remaining in electrical connection together. The field is thus self excited. The engine is then slowed down, the field gradually dying out.

When the dynamo is wanted again, the pin or latch which locks the blade of the field switch to the blade of the main dynamo switch is withdrawn and the field switch blade is brought up in contact with the clips connecting to the neutral bus. This instantly charges the field and full field is had by the time the engine is up to speed. By means of this method the main circuit and the field are opened at the same time and the discharge of the field takes care of itself in the slowing down of the machine, there being no break in the field at any time.

A further advantage of this method of exciting the field is that as the field is connected on one side to the opposite pole to the neutral (that is the positive or the negative) it is charged from the common or the auxiliary bus, depending on which bus the dynamo is connected to. When running on the auxiliary bus the higher pressure maintained there gives a greater working margin in the regulating resistance box than is possible when the fields are charged from the common bus. A further advantage of this method is that it greatly simplifies the apparatus used for throwing over the dynamos from one side of the system to the other in the three-wire system. It is usual to employ a throw-over head board switch on the dynamo from which three cables are led to the switch-board, being connected to the positive, negative and neutral buses, respectively. In the Donshea method no head board change-over switch is required and but two cables from the dynamo to the switch-boards need be run. One of these cables would be the permanent connection to the neutral bus through switch and ammeter and the other would be connected to a change-over switch connected to both the positive and the negative busses.

This system of field charging can be readily applied to existing switchboard construction by the simple addition of a special Donshea switch directly attached to the blade of the neutral dynamo switch as ordinarily constructed.

AMERICAN APPARATUS IN THE MUNICIPAL LIGHTING PLANT, ODESSA, SOUTHERN RUSSIA.

THE electric lighting station at Odessa, installed in 1888, has recently received an interesting addition in the shape of three American alternators with full equipment, in the construction and installation of which special and peculiar requirements had to be met. The old plant consisted of two Ganz low frequency alternators. In ordering the new machines of higher frequency and higher potential, it was necessary that the current furnished should not only supply the Ganz transformers but run in conjunction with the old generators, and as the municipality would grant no further space for a station, the installation had to be crowded into very restricted quarters.

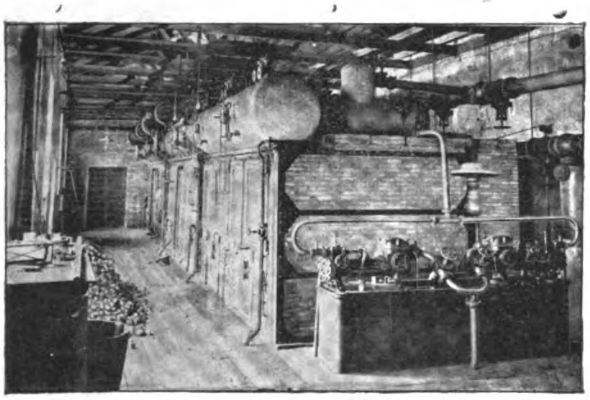
The original plant was erected to light the Municipal Theatre at Odessa, one of the handsomest buildings in the South of Russia, and comprises two 80 K. W. Ganz alternators, directly coupled to non-condensing engines. The voltage of the primary circuit is 1850 volts and that of the secondary 60 volts, the distance between the station and the theatre being about 2,700 metres.

The success of the illumination of the theatre was such that electricity was also supplied to other neighboring buildings. The capacity of the station soon became severely taxed, and in June, 1893, the municipality at Odessa decided to increase the existing plant to meet the constantly increasing demands. After considerable competition the contract for the addition to the station and for the exploitation of the new installation for 15 years, was granted to Mr. J. Margulis, a well known engineer of Southern Russia. He decided to use the Thomson-Houston system of lighting as it seemed the better to respond to the local requirements than any of the European systems which were offered.

The new steam generating plant consists of two Collet water tube boilers, built in Paris, with a capacity of 2,250 kilog. of water per hour at a pressure of 12 kilogs. per square centimetre. The boilers are set in one battery and are fed by two Worthington pumps. Attached to each of these pumps is a special reservoir in which the water flows from the condenser. The piping is so connected with that of the former installation that all the boilers work in parallel.

The steam engines are vertical tandem compound condensing machines of 175 H. P. each, from the works of Franco Tosi of Legnano. They run at 260 R. P. M. and are furnished with governors which regulate the speed so that the variation is only $2\frac{1}{2}$ per cent. between full load

and no load, a condition necessary to obtain the satisfactory operation of alternators in parallel. Each engine is furnished with an independent jet condenser driven from a pulley on the engine shaft. The condensers are placed beneath the engine room. In order to cool the water in these condensers a Chaligny aero-refrigerator has been installed and to avoid the employment of supplementary pumps to raise the water discharged from the condensers the apparatus has been placed as low as possible, while the air pumps have been specially constructed to throw the water to a height of 3½ metres. A small steam engine is employed to drive a fan forcing a current of air through the tubes over which the hot water flows. By this arrangement the dimensions



BOILER ROOM, ODESSA ELECTRIC LIGHT STATION.

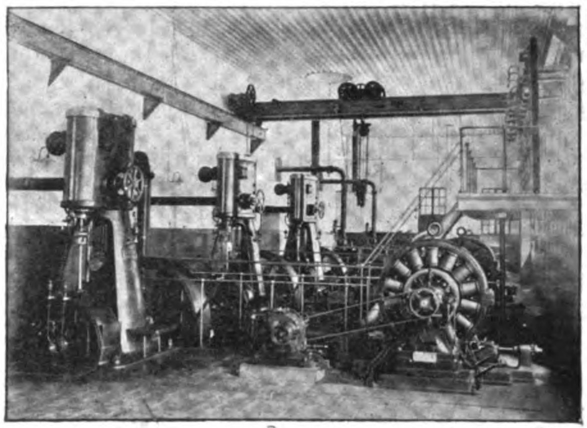
of the refrigerator have been greatly reduced and a vacuum of from 65 to 68 centimetres of mercury can readily be maintained with an expenditure of water not greater than that necessary to feed the boilers under ordinary conditions.

The three alternators are Thomson-Houston 120 kilowatt, 14 pole 1,070 revolution machines of standard frequency, giving 2,000 volts at no load and compounded for 2,200 volts at full load. They are driven by perforated leather belts from the engines and as the station building was already constructed when they were installed, the greatest distance allowable between shaft centres was 4.50 metres.

The exciters are of the Volta type, built in Paris by the firm of Postel-Vinay. They are compound wound and are driven from pulleys fixed to the alternator shaft. Each exciter has a capacity of 3,300 watts at 125 volts and suffices to excite all three alternators simultaneously.

The switchboard is built up of marbleized slate panels. The switches for the primary circuits are mounted on separate slate bases and have a further insulation of ebonite. The exciter switches are three pole and the main switch four pole, two of the poles being used for equalizer connections. The rheostats in the exciting circuits are arranged for connection in groups in order to vary the potential of all the dynamos simultaneously and thus avoid any unequal distribution of load. Each exciter is provided with an ampere meter and a fuse; each alternator with an ampere meter and station transformer with its voltmeter. Each primary conductor is provided with a fusible cut-out at its point of connection with the main switch. The single pole switches for the alternator and exciter circuits are so arranged that the circuits are broken through incandescent lamps, and these lamps are also used as pilot lamps for the individual machines. The secondary circuits of the station transformers are so arranged that by closing two small single pole switches the phase lamps for the machines are brought into circuit. By means of special grouping of the reactive coils and a special commutator, no excessive rush of current is produced when the alternators are thrown in parallel, even when the phases are in opposition. A momentary fluctuation of the lights is produced on account of short circuiting the machines through the reactive coils, and it is, therefore, advisable to use the phase lamps and to close the main switch the instant the machines are in phase. As a speed variation of from 2 per cent. to 2½ per cent. between full load and no load exists in the engines, the pulsations in the lamps vary between 150 and 180 per minute. In order to diminish these pulsations, as much as possible, before throwing the machines in parallel, one or other of the following means is employed. The first consists in closing the valve on the engine driving the new alternator until this revolves in synchronism with the others under full load, and at this moment the switch is closed and the valve opened. The second method consists of closing the valve until the speed of the engine falls below that of those already in service; the valve can then be opened rapidly and the switch on the new alternator closed the moment the machines come exactly into phase.

According to the specifications of the municipal authorities, the three 120 K. W. alternators must work in parallel, and be so arranged that the Ganz circuits with transformers at 40 periods at 1,850 volts can be supplied by the Thomson-Houston alternators at 125 periods per second at a potential of 2,000 to 2,200 volts. That is to say, that at any given moment the Ganz machines can act as reserve for the Thomson-Houston group and the Thomson-Houston machines can act as reserve for the Ganz dynamos. In order to do this, a compensator is employed to bring the potential down to that of the Ganz circuit. The compensator is furnished with a number of terminals in order that the potential may be varied, if the load on the Ganz circuit varies in proportion to that on the other circuits. The speci-



ENGINE AND DYNAMO ROOM, ODESSA, RUSSIA, ELECTRIC LIGHT STATION.

fications stipulated that there should always be a dynamo in reserve, and the two Ganz machines are used for this purpose. Another circuit is furnished with Ganz transformers, but takes its current from the Thomson-Houston compensator. In case of accident, the 40 period circuit can be taken off the Thomson-Houston machine and connected to the Ganz dynamo and the result is that the same flexibility is obtained in the system as if all the dynamos were of the same frequency and all operated in parallel. The experiments carried out by the municipal engineers before the city accepted the plant proved that with the necessary precautions the American alternators operate in parallel as advantageously and as readily as direct current machines. Excitation of the individual machines can be varied; the line potential is that which each machine would have if it ran individually under similar conditions; the change from condensing to non-condensing or vice versa can be effected upon any engine when its dynamo is running in parallel with the others, without difficulty. Any number of alternators can be thrown in parallel with or without load as easily as direct current machines under similar conditions.

The plant in question is now considered as one of the

most satisfactory operated in Europe, and it is more than gratifying to find that in spite of all the deserved and admissible claims made for European electrical machinery, American apparatus seems to be that which at this present moment is meeting with the greatest success in Europe whether for lighting or for railway purposes.

THE POLLAK CURRENT RECTIFIER FOR CHARGING STORAGE BATTERIES FROM ALTERNATING CURRENTS.

ONE of the decided novelties exhibited at the World's Fair in Chicago was the current rectifier of Mr. Ch. Pollak, of Frankfort on the Main, Germany. This apparatus, which was illustrated and described in THE ELECTRICAL ENGINEER of Sept. 13, 1893, is intended to convert alternating into continuous currents for charging storage batteries. Its construction is such that of the pulsating current obtained by rectifying the alternating current, only such portion is used as is equal to or higher than that of the battery, all other portions of the current impulse being rejected for obvious reasons.

In a recent number of the *Consular Reports*, U. S. Consul Frank H. Mason, at Frankfort, Germany, draws attention to the successful operation of the Pollak rectifier and gives the results of some of its work in the Pollak Accumulator Works in Frankfort. Electricity is supplied at Frankfort from the municipal central station at 7¼ pfennigs (a little more than 1¾ cents) per unit, in the form of single-phase alternating current of 3,000 volts. At the accumulator works, this current is reduced by transformers to 65 volts and then rectified and fed to the storage batteries.

Four of these rectifiers, each for 350 amperes, have been in continuous service day and night at the works of the company in Frankfort for more than a year, with such complete success that the system may be fairly claimed to have passed the experimental stage. Their efficiency is stated to be 96 per cent.—that is, the alternating currents are converted into direct ones with a net loss—including

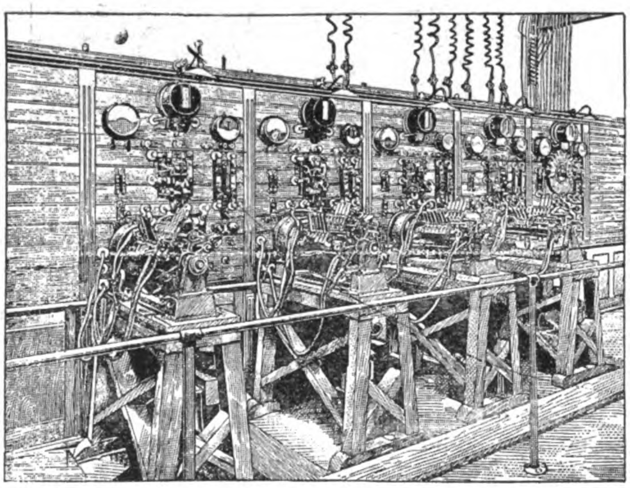


FIG. 1.—POLLAK CURRENT RECTIFIERS.

the slight reaction of about 2 per cent. on the transformer—of only 4 per cent.

The current from the rectifiers also operates arc and incandescent lamps, runs continuous-current motors of all sizes down to the smallest, and is used for charging storage batteries, which is the chief function of the Frankfort company. The rectifier and its accessories are exceedingly compact, the whole installation, including seven transformers, occupying only 25 square yards of space, within which compass the apparatus and its capacity might easily be doubled should occasion require. The rectifiers are small, require no other foundation than wooden trestles resting on a solid factory floor, and demand no more oversight than an ordinary dynamo. Mr. Mason states that from the testimony of the inventor and the numerous experts who have visited Frankfort specially to examine the system, the current supplied by the new rectifier is for

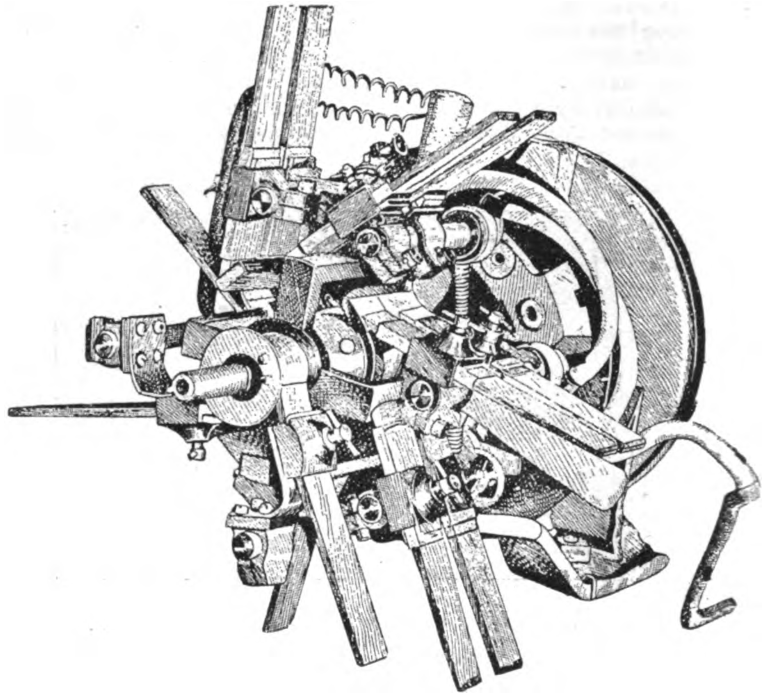


FIG. 2.—POLLAK CURRENT RECTIFIER.

all practical purposes identical in value and effects with the continuous currents hitherto produced in the ordinary manner. We may add that the apparatus has been recently patented in this country.

THE ALLEGED "OUTAGES" IN CINCINNATI.

Superintendent Beggs, of the Cincinnati Edison Co, appeared lately in response to the call of the local Board of Administration to show cause why the city should not settle the outages on the basis of the Police Department Reports, recently mentioned in these columns, and he evidently succeeded in doing so. He was armed with reports of the city inspectors placed in the central lighting station last month, and set out to show that the system of reporting lights was defective. A time elapses between the moment when the officers discovers the light out and the time it gets through two reports and to the central lighting station. Again, officers report a light out just before they change watch, and it stands as "out all night," even if relighted a short time afterward. Reports were received last month from places where no lights are located. The point was also raised that if the time for lighting the city in the evening is 5 o'clock and the lights were not turned on until 5:55, the contract did not provide that as an outage and it should be deducted.

The outcome was that the board decided to settle on the Edison figures, and to notify Superintendent of Police Deitsch that the police do not report to the central lighting station all of the outages reported to the Board of Administration.

AN EDISON STATION FOR LOS ANGELES.

The Los Angeles Edison Light and Power Company is the name of a new corporation that has been formed for carrying on a general electric lighting and power supplying business. The head of the company is Charles R. Lloyd of San Francisco. It is understood that the new company proposes to commence inside of sixty days putting in its plant. The promoters of the new enterprise say that the plant to be put in will be the most modern in its equipment of any in the United States. It is intended to spend $500,000. The wires will all be laid underground in the business portion of the city. Several Los Angeles men are interested in the enterprise. The plant is to have a capacity for 30,000 incandescent lamps and 500 arcs.

A GOOD CROSS-EXAMINER.

A short time ago a large factory, fitted with the most modern appliances, including electric light, caught fire, and despite the most strenuous efforts of the fire brigade, was almost demolished.

The following morning a newly-appointed member of the force was dispatched to the spot, with a view of ascertaining how the fire originated. After closely interrogating the manager of the factory, he asked to see the man who was responsible for the electric light.

The manager stated that the electric switches were under his sole control.

"Then you are the man that lights up the electric affair?" said the policeman.

Manager—That is so.

Policeman (bubbling over with excitement)—Now, be careful how you answer my next question, 'cos if it ain't satisfactory, it will be took as evidence against ye. When you lighted the electric light last night, where did you throw the match?—*Pearson's Weekly.*

ELECTRIC LIGHTING SALE ON STATEN ISLAND.

The sale at auction of the property of the Electric Power Company of Staten Island has been fixed for Jan. 29. This company was practically owned by Erastus Wiman. At the time of his failure it passed into the hands of Albert B. Boardman, as receiver, and he has since operated the plant. The company has contracts for lighting New-Brighton and Edgewater, and there is expected to be competition for the property between the unsecured creditors, represented by Austin B. Fletcher, and the Thomas syndicate, which owns nearly all of the bonds. The property does not include the new plant at Livingston.

GEDNEY CHANNEL LIGHTS CRUSHED BY ICE.

Large quantities of ice were taken to sea by Sandy Hook last week by the ebb tide. The ice came mostly out of the Shrewsbury River and from the Jersey shore. Every electric light on the buoys marking Gedney Channel across the bar was extinguished by the ice, and only the red light on the buoy at the Southwest Spit was left in working order. The Lighthouse Department was notified and new lamps were supplied.

THE PADUCAH, KY., MUNICIPAL PLANT IN BAD SHAPE.

Mr. C. C. Chapman, who has been employed as superintendent of the Municipal Electric Light Plant at Paducah, Ky., has resigned pursuant to a request from the council. For some time past the electric light system has been in bad shape. A committee was appointed and decided that the defective service was due to the incompetency of the superintendent.

MORE MONEY NEEDED FOR THE ALAMEDA MUNICIPAL PLANT.

At the last meeting of the Alameda, Cal., Municipal Trustees plans and specifications were read for the installation of additional electrical machinery to the city's plant, involving an outlay of some $15,000. It will necessitate the erection of a new building, the placing of a new engine and boilers and of a new dynamo of a capacity of 4,000 incandescent lights. Proposals will be invited at once for the work. The money to pay for the same was raised by increasing the taxation from $1 on each $100 of assessed value to $1.22. At the time the tax rate was fixed it was not stated what the increase was for, as it would undoubtedly have raised a storm that could not have been withstood; but as the affair blew over and feeling subsided the new improvements were proceeded with. The electric works absorbed $27,000 of the public funds last year, when a great deal of the plant was renewed, at least $19,000 of it going for construction. But it is claimed this further outlay is necessary to make the incandescent branch profitable. It is the purpose to have a capacity of at least 4,000 incandescent lights for the plant.

A COSTLY PISTON ROD FOR A CENTRAL STATION.

A special despatch from Burlington, Ia., of recent date, says: A broken piston rod in the electric light works caused the shutting off of all street and residence lights in this city. A new rod was ordered from Sioux City, and to have it here in time for to-night's lighting the managers of the electric plant chartered a special train from Sioux City, Iowa, to Cedar Falls, over the Northwestern to make connection which would bring it here on time. It makes the rod the most costly one on record.

INDIANAPOLIS, IND.—An ordinance has been passed giving the Board of Public Safety power to make rules in regard to electric wiring and to confer police powers on an electrical inspector, paid for by the insurance companies.

NEWS AND NOTES.

THE ANNUAL ELECTRICAL AWARDS OF THE ACADEMIE DES SCIENCES.

The last number of the *Comptes Rendus* is taken up with announcements of the 1895 prizes awarded for scientific, mathematical, and engineering work. We append a list of the prizes awarded for electrical researches:—The MONTYON PRIZE of 700 fr. has been awarded to M. Galliot for his successful introductin of an electrical towing arrangement for a distance of 6 kilometres on the Burgundy Canal. Some two years ago M. Galliot decided to electrically utilize the head obtainable between the feed-water reservoir and the third lock on either side of it, and since then all barges have been towed up and down by a motor-barge deriving its current from a trolley wire running along the banks of the canal, and connected to turbine-driven dynamos. The water necessary for the operation of the locks is not interfered with, the turbines being fed by the large volume of water necessary to make good the losses by infiltration.—The LA CAZE PRIZE of 10,000 fr. was awarded to M. Edmond Bouty, Professor at the Paris Faculty of Sciences. M. Bouty discovered a curious phenomenon connected with electro plating, to which he gave the name of "electrostriction." For instance, if a thermometer bulb be copper-plated an appreciable permanent displacement of zero is found to take place, corresponding to a pressure of several atmospheres. M. Bouty's explanation is, that this phenomenon of expansion or contraction is due solely to abnormal temperature, caused by the Peltier effect. Recently M. Bouty has investigated the influence of the layer of air left between the metal plates of a condenser and the solid dielectric, and, finding it considerable, M. Bouty now silvers the faces of his mica condenser sheets.—Another LA CAZE PRIZE was awarded to M. H. Le Chatelier, well known for his work on the electric pyrometer. By the aid of this instrument he has, amongst other things, observed that at 580° C. quartz suddenly expands, though its molecular composition is not modified; the process is reversible.—As already announced, the LECONTE PRIZE of 50,000 fr. was awarded to Lord Rayleigh and Prof. Ramsay for their discovery of argon.—The GASTON PLANTÉ PRIZE, a biennial one of 3,000 fr. was awarded to MM. J. and P. Curie for their work in "piezoelectricity."—The KASTNER-BOURSAULT PRIZE of 2,000 fr. was awarded to M. Baudot, the inventor of the well-known multiple-writing telegraph much used in France.

ELECTRICITY ON THE CANALS.

There has just been issued an important supplemental report to the annual report of the Superintendent of Public Works. It is written by Charles R. Barnes, State electrician, of Rochester, and treats of the proposed introduction of electricity upon the canals. Commenting upon the report the Superintendent says: "I am very sanguine that electrical canal-boat propulsion is not only possible, but also that the devices which have been already tested and are being constantly improved will result in a perfect system within the time required for the general improvement of the canals now inaugurated. The test seems to be satisfactory and to indicate that as soon as the details of the system are so worked out as to meet every contingency of canal-boat traction, it will become a cheap and favorite one with boat owners and forwarders; and that the cost of traction will be largely reduced and the speed greatly increased."

The report of Mr. Barnes describes the Lamb electric-towing system, which consists, essentially, of a stationary cable-way, supported by a line of poles along the canal bank, and electric motor carriages travelling thereon and towing a boat or boats attached thereto. It is familiar to readers of THE ELECTRICAL ENGINEER.

EDUCATIONAL.

ELECTRICAL ENGINEERING AT MAINE STATE COLLEGE.

THE Maine State College has recently installed as an addition to the electrical laboratory and for the practical purpose of lighting the grounds and buildings a 40 horse-power multipolar generator built by the Eddy Electric Mfg. Co., Windsor, Ct.; also a 20 horse-power bipolar dynamo manufactured by the Belknap Motor Co., of Portland, Me. These are belted to a jack-shaft, run by a 60 H. P. Hamilton-Corliss engine. The boiler is the Heine water tube type of 85 H. P. The plant also includes 58 Bradbury-Stone 800 ampere-hour storage cells, which take care of the light load after eleven o'clock.

The college, located at Orono, Me., ranks well among New England's technical institutions.

Power Transmission.

ELECTRICAL POWER FRANCHISE FOR BUFFALO.

BY I. C. WOOD.

THE Niagara Falls Power Company having, on January 14th, formally accepted the grant approved by Mayor Jewett on December 16th, 1895, the elongated query as to whether or not the power generated by the Falls of Niagara would ever run the cars, light the streets and turn the wheels of industry in Buffalo, may be now answered affirmatively. For we take it as assured that at least the Buffalo Railway and the Buffalo General Electric Company will find it convenient to use, and the Power company find it profitable to furnish this power.

The terms of the grant were practically dictated by Attorney Rankine of the Power company, hence are quite favorable to that corporation. Nevertheless, the interests of the city, though at times subordinated to the desire of some to have power at any price, were intelligently provided for by the joint committee which is responsible for the city's approval of the charter as it now stands.

The grant covers a term of 66 years from date of acceptance; it requires the furnishing of 10,000 H. P. on or before June 17, 1897, and an additional 10,000 H. P. per year for four years thereafter.

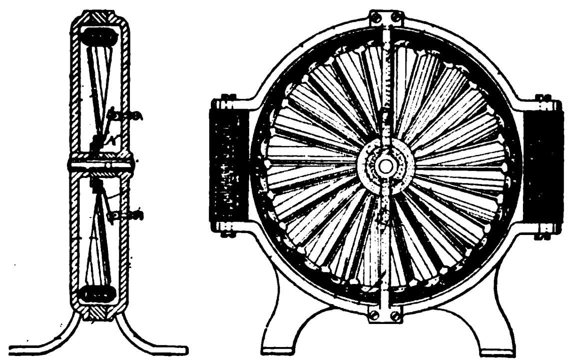
Commencing with the year ending January 15th, 1903, the Niagara Power company must pay, at the end of each year, 2½ per cent. per annum of its "gross receipts from all electricity sold or furnished for lighting, heating or power purposes to any person, company or corporation for use or to be used in said city [Buffalo] regardless of whether such electricity shall be furnished or delivered under this grant." At the end of the twelfth year (1914) of such payment, i. e. eighteen years after acceptance of the grant, there is to be a readjustment of the percentage of earnings paid to the city which adjustment is "to be made by three arbitrators, one to be appointed by the company, one by the Mayor of said city, and the two so elected to appoint a third, and such arbitrators by a majority vote shall have full power to increase or decrease the percentage to be paid or otherwise regulate or adjust the same as to them shall seem just and equitable."

In the controversy over the terms of the franchise, it being admitted by Mr. Rankine that the power would be distributed in Buffalo by a sub-company, the following question arose, viz:—Might not the power company sell its product to this sub-company at a nominal price, so as to reduce its (the power company's) own gross earnings from Buffalo business, and so scale down the amount upon which it would be required to pay to the city on the 2½ per cent. basis? The inference was that though ostensibly losing money on its contract with the sub-company, the profits of such sub-company would eventually reach the treasury of the principal company. To prevent such methods, a clause was inserted in the grant permitting one assignment of the franchise, after six months from its acceptance, on condition that the assignee company agree to pay the same as would be required of the principal company. This, of course, meets the point, except that it is still possible to sell *all* the power to one, two, or three large consumers, at a nominal price, and, by being interested in these concerns, the company could take its profits from them and so reduce its 2½ per cent. tax. But the idea of such methods being pursued by Mr. Adams and his associates in the power company is altogether too ridiculous.

No price has been set for power delivered in Buffalo. This point was the centre of the franchise fight, and the company won. It early took the position that the actual cost of transmission was not exactly known, and that Buffalo must rely upon the business proposition that the company must, someway or other, reduce the price to where they could successfully compete with the present cost of power, minus cost of changing to electrical operation. The grant provides against discrimination or favoritism after a price has once been made.

DIEHL'S NOVEL FAN MOTOR.

MR. PHILIP DIEHL, the well-known inventor, has added many ingenious devices to the list of electrical apparatus, and one of the latest is a novel fan motor, the construction of which is clearly shown in the accompanying engravings. It will be noted that the fan-



NEW DIEHL FAN MOTOR.

blades are arranged inside of a ring-armature, with the field-magnet located outside of the armature. The commutator is placed on the hub of the fan, and the fan-blades are utilized as conductors between the commutator-sections and the armature. In thus utilizing the fan-blades as conductors they are insulated from each other and the armature-ring is wound in sections corresponding in number to the number of the fan-blades, the latter being of course electrically connected with the commutator and armature sections.

A POLYPHASE TRANSMISSION PLANT FOR GUATEMALA.

Messrs. Siemens and Halske, of Berlin, have in course of construction a long-distance transmission plant which is to be operated by the "Empresa Eléctrica de Guatemala," and which is intended to carry electric energy for light and power purposes to the town of Guatemala from a waterfall 22¼ miles distant. The system of transmission is the three-phase, at a pressure of 10,000 volts, with step-up and step-down transformers at either end of the line. Power is to be derived from the outlet of a lake giving 2,000 litres per second, with a fall of 87 metres. At present, therefore, some 1,300 H. P. is available. But it is contemplated in the near future to carry out works permitting the water of the lake to be accumulated during the daytime; this will bring the available power to 5,000 or 6,000 H. P. The plant now in view consists of a set of two horizontal Nagel and Kaemp turbines of 520 effective horse-power each, running at 200 revolutions per minute. Each turbine is coupled direct to a Siemens and Halske three-phase alternator capable of generating 425 kilowatts at a pressure of 850 volts. The current is transformed by a set of four transformers from the pressure of 850 to 10,000 volts, then transmitted to the town by a three-conductor aerial line having an aggregate section of 105 sq. mm., the maximum loss in the line amounting to 10 per cent. On reaching the town the pressure is lowered again by another set of four transformers from 9,000 to 1,000 volts, the current being then distributed to the supply network of the town. The distributing conductors are overhead, carried on iron poles.

MORE ELECTRICITY FOR MOLINE.

The Moline Water Power Company has awarded the Trump Manufacturing Company of Springfield, Ohio, the contract for an important extension of the company's capacity for generating electric power by means of water wheels. The new turbines, twelve in number, with the present steam power will produce a total of 6,000 horse-power. The whole improvement will cost $140,000.

MR. W. S. KELLY, a well known electrical engineer of Boston, is pushing a scheme for generating electric power at Howe's Pond in Readsboro, Vt., and transmitting the current to North Adams and other points.

ELECTRIC TRANSPORTATION.

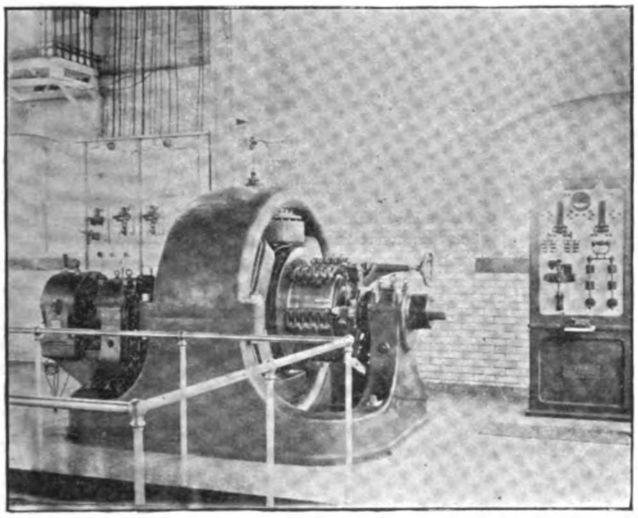
POWER EQUIPMENT OF THE NIAGARA FALLS RAILWAYS.

BY ORRIN E. DUNLAP.

THE Buffalo and Niagara Falls Electric Railway, the various lines of the Niagara Falls and Suspension Bridge Railway and the Whirlpool and Northern Electric Railway are now enjoying a power service from the central station of the Niagara Falls Power Company. In reducing the voltage and changing the current from alternating to direct, a rotary and a pair of static transformers are used, views of which are given in the accompanying engravings. The rotary transformer is placed in the northeast corner on the main floor of the power house, while the static transformers are located below the main floor. These transformers were furnished by the Westinghouse Company.

It is well known that if the armature of any direct current dynamo be tapped at points which are electrically 180 degrees apart, an alternating current can be drawn therefrom. If now the dynamo be run as a motor from the direct current end an alternating current can be drawn from collector rings tapped on at the points above mentioned; and, vice versa, if the dynamo be run as a synchronous alternating current motor a direct current can be taken from the commutators. This last is the principle on which is constructed the 500 H. P. rotary transformer supplying the electric railways around Niagara Falls.

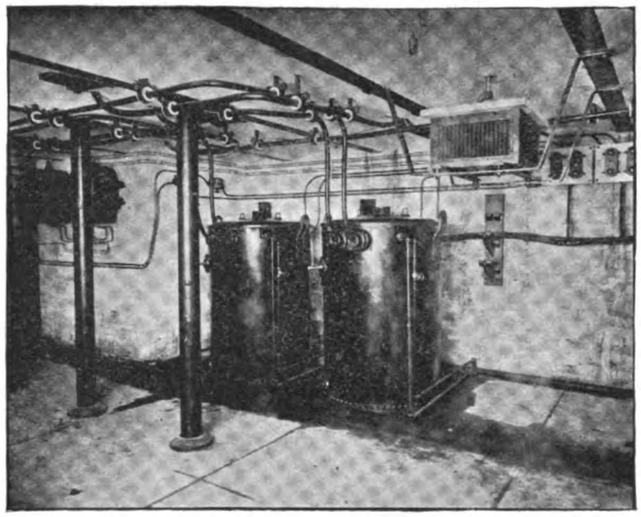
The source of power is the great 5,000 H. P. dynamos.



ROTARY TRANSFORMERS IN POWER HOUSE OF NIAGARA FALLS RAILWAY SYSTEM.

The function of the rotary transformer and its accompanying static transformers is to change the 2,000 volt alternating current into a 575 volt direct current so as to adapt it for use on a street railway circuit equipped with standard street railway apparatus. The current is brought from the main bus bars at a potential of about 2,250 volts by four 600,000 C. M. cables. This size of cable gives ample room for the expansion of the system. Four cables are necessary, as the current is distributed on a quarter phase system, with two cables for each phase.

These cables are connected to the middle points of two double-pole, double-throw switches. Throwing the switches up throws the current into two auxiliary static transformers, the secondaries of which are connected to a quarter-phase starting motor. The armature of this starting motor is on the same shaft as the rotary transformer armature. The method of starting is to first throw both switches up; this throws the current into the starting motor and the shaft starts and is brought up to speed. Now the field circuit of the main armature is closed and voltage allowed to build up. The phase relation of the armature is determined by synchronizing lamps. These synchronizing lamps are two in number and placed in series with the secondaries of two 2,000 to 100 volts converters, the primaries of which are attached, one to the main dynamo circuit and one to the 2,000 volt side of the static



STATIC CONVERTERS IN POWER HOUSE OF NIAGARA FALLS RAILWAY SYSTEM.

transformers feeding the rotary. When the armature is near synchronism, these lights will slowly grow bright and then dim. By watching these lamps one can choose the proper moment to throw the switches down. This done, the dynamo current passing through the two static transformers is reduced in voltage by them from 2,250 to about 440, and the current increased in the same ratio. The current at this reduced voltage then passes into the alternating current end of the revolving armature, running it as a synchronous motor. In its passage through the revolving armature the voltage is increased in the ratio of 7 to 10, which makes the final direct current voltage about 600, which is fed to the railway circuits.

THE SUBMARINE BOAT "LE GOUBET."[1]

THE most recent addition to electrically propelled boats is the "Le Goubet," just finished in Paris, which embodies a number of novel features, largely the result of experience gained with a smaller boat of the same name, built several years ago. The present "Le Goubet," which is illustrated in the accompanying engraving, Fig. 1, mounted on a truck passing through the streets of Paris, measures 8 metres in length, with a maximum beam of 1.75 metres. Its weight is about 10 tons, and it is built in three sections, which are bolted together, with a false keel, weighing 1,200 kilogrammes.

Fig. 2 shows a view of the interior of the boat looking toward the bow. The operator has before him the handles *a a* opening to the sea water the discharge of the pumps, the cocks of which are shown at *b b*; these pumps, according to the position of the valves the hand wheels of which are shown in *c c*, expel the water which serves as ballast or the vitiated air, which owing to the increased density of the carbonic acid, sinks to the bottom of the boat.

Behind the operator's head at *d* is the "postal" apparatus, by means of which a small hermetically sealed case

1. From *La Nature*.

containing despatches is put into communication with a vertical chimney communicating with the sea water. The object deposited in the postal box rises to the top of the water owing to its small specific gravity. The cone shaped bow also contains the steel tubes which hold the compressed air used as a reserve for breathing purposes.

Looking toward the stern of the boat on the interior the view shown in Fig. 3 is presented. Here is seen the electric motor, operated by batteries which will be ranged on each side of the boat. The machine above which is shown the hand wheel which controls the movements of the screw hides the regulating gear wheels. On the walls of the prow are shown the torpedo discharging apparatus. Just below the lookout tower is placed a lever, which by means of a quarter turn detaches the false keel which acts

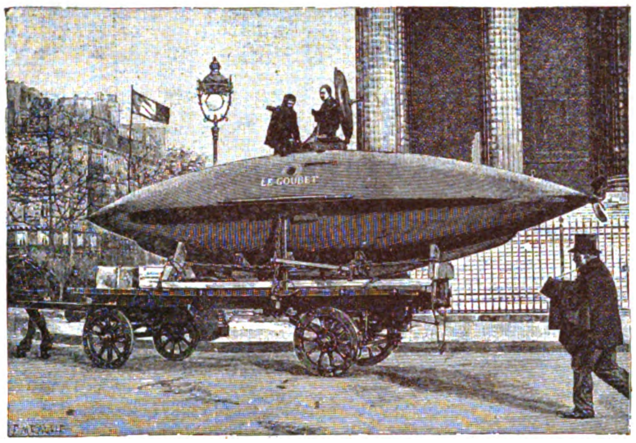


Fig. 1.—The Submarine Boat "Le Goubet."

as a safety ballast, so that the boat may immediately arise to the surface in an emergency. Ordinarily the boat will float at the surface, the small lookout cap alone being visible above the level of the sea, but upon entering the dangerous zone a little water introduced into the bottom

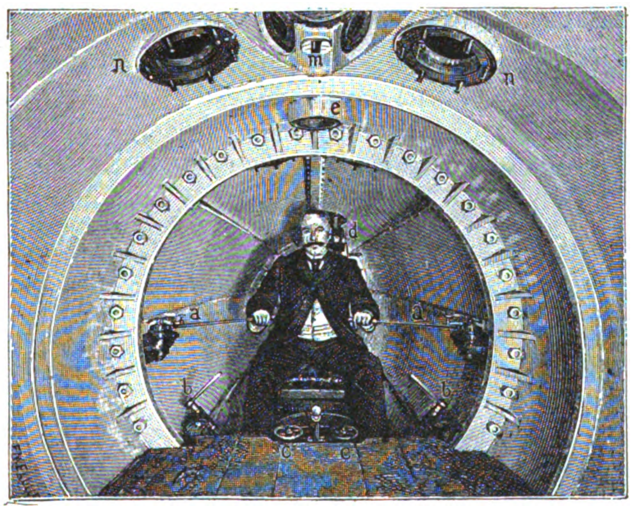


Fig. 2.—"Le Goubet."—Looking Towards the Bow.

of the boat sinks it to the proper depth, about four or five metres, and ten metres if necessary.

The dead lights are but a small help for the purpose of making observations, but in order to give those inside accurate information as to their location, a vertical tube consisting of a system of telescopes and reflecting prisms is pushed up from the top of the boat, rising above the level of the water. This tube can be revolved in any direction, and by observing it the commander of the submarine vessel can obtain a full view of what is going on in any direction. In order to keep the boat at the exact level below the surface desired, a pump ejects or injects

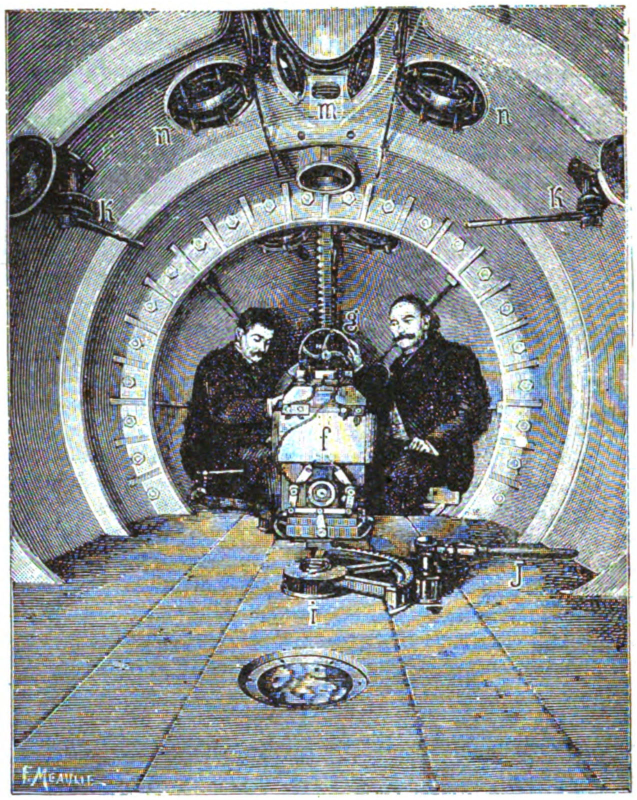


Fig. 3.—"Le Goubet."—Looking Towards the Stern.

water into the bottom. This pump is operated in one direction or another automatically by the position of the needle of a pressure gauge.

Electric energy is supplied by bi-sulphate of mercury cells, which the inventor has selected in preference to accumulators, owing to the fact that in spite of all precautions hydrogen is disengaged, which is not only bad for breathing but also introduces the danger of explosive gases into the boat, which may be fired by a spark from the motors.

TERMS OFFERED FOR THE NEW SYSTEM IN CLEVELAND, O.

The Everett system of street railways, which is proposing to build traction lines in Cleveland, has offered to sell 3 tickets for 10 cents, 8 tickets for 25 cents, and 32 for $1, with free transfers; to limit the hours of work for motormen to 10 per day with pay at the rate of $1.90 a day for 10 months, and $2.10 thereafter, to maintain a car service equal to any now given on existing lines in Cleveland; and to take a franchise for 25 years, at the expiration of which the city may purchase the property at its appraised value, to be determined by arbitration. Should the company retain the franchise for more than twenty-five years, the subsequent renewals shall be for periods not exceeding five years. Moreover, the company binds itself not to consolidate with other existing companies without the consent of the city. The Mayor of Cleveland has agreed to these provisions, but will insist on a track tax also.

PHILADELPHIA MUNICIPAL CARS.

A bill is now before the Philadelphia City Councils, for the purchase by the city of the Frankford and Southwark Passenger Railway at $645,538.37, and authorizing the city to purchase at that price and lease to the best bidder for a term of ten years. The lessee is to pay as a bonus to the city the money to be paid the company, fulfill all conditions required of the present company, and give free transfers on fares not exceeding five cents. The bidding is to be based on the proportion of gross earnings to be paid the city.

ELECTRIC TRACTION ON BROOKLYN BRIDGE.

The general plan for the trial electric cars on Brooklyn Bridge is to mount four fifty horse power motors on the axles of one car of each train. These passenger car locomotives will remain with the trains at all times, and will switch the trains from the incoming to the outgoing platform and to the tilting sheaves, where the trains are attached to the cable. If, while ascending the 3.78 per cent. grade, the grips should slip and the train be in danger of stopping, the electric motors can be employed to assist the train over the summit.

During the early morning hours, when the cable is not running, the trains may be operated entirely by electric motors. By supplying each train with its own facilities for switching, the interference of the locomotives with the incoming and outgoing trains will be avoided and the complexity of the switching reduced one-half.

The four motors are of the General Electric 1,200 type, adapted to this equipment. Each motor weighs about 3,000 pounds, and will exert a draw-bar pull of 1,320 pounds, at eleven miles an hour. The frame of the motor and the gearing are of steel. The motor is suspended so as to relieve the axle of nearly all weight. The trucks are of the same style as used on the Chicago West Side Elevated Road, and have the combined advantages of a passenger and locomotive truck. They are made by the McGuire Manufacturing Company of Chicago. The controlling apparatus is in duplicate, and the motors can be operated from either platform. In order to avoid obstructing the platform, the controllers are located underneath the car body. These controllers are of the well-known L 4 type, which have given satisfactory service in Chicago. Each controller can operate the four motors, or any two of them, as desired.

It is also the desire of the trustees to heat the cars by electricity, and twelve electric heaters will be placed in each car. These heaters, made by the Consolidated Car Heating Company of Albany, have a maximum capacity of 40 square feet of radiating surface at 400° Fahrenheit. Five degrees of heat can be obtained by means of a controlling switch.

The electric car-lighting system of the bridge, is equipped with apparatus nearly all of which was made by the General Electric Company, and has given entire satisfaction since its installation, nearly a year ago.

OBITUARY.

THOMAS MARTIN.

The death is announced by cable of Mr. Thomas Martin, J. P., of Gravesend, England, father of one of the editors of THE ELECTRICAL ENGINEER. The deceased, whose family had long been connected with the old East India Co., began active life in the service of the English Trinity House, for whom he did a great deal of work in re-charting the North Sea. This important task led to his being attached for special navigation duties to the British Baltic fleet in the Russian War, and also brought him in close touch and friendship with many of the early submarine cable promoters and engineers on both sides of the Atlantic, including those interested in the "Great Eastern," which was entrusted to his care in English waters. His acquaintance with sea floors was intimate, and he was frequently consulted as to buoying, grappling and currents. For nearly the last quarter of a century he had been in charge of the deep sea pilotage of the Peninsular & Oriental Steamship Co., which has the finest fleet of steamers sailing under the British flag. Mr. Martin had also been in the Commission of the Peace for several years. He leaves a widow, niece of Dr. Samuel Smiles, the biographer of Stephenson, and author of "Self Help."

DR. F. W. SHAIN.

It is with extreme regret we record the death of Dr. F. W. Shain, of Jersey City, who was thrown from his buggy last week and never recovered consciousness. He was 45 years of age and at one time member of the Board of Education. As the brother of Mr. C. D. Shain he had a large circle of acquaintance among electrical men, by all of whom he was highly appreciated for his many manly qualities.

JOHN W. DUXBURY.

John W. Duxbury, superintendent of the Central Division of the New England Telephone and Telegraph Company, died on Jan. 13, at Lowell, Mass. Although in declining health for a year, he attended to his duties until last Thursday, when he strength failed. He leaves a wife and two daughters. Mr. Duxbury was born in Dover, N. H., Oct. 4, 1844. He received his early education in that place and was graduated from Bowdoin college in 1863. He immediately entered the employ of the Western Union Telegraph Company, and in a short time became connected with the army telegraph corps at Chattanooga, where, though only 19, he had full charge.

After the war Mr. Duxbury re-entered the employ of the Western Union Company and later he was connected with the Providence telephone exchange. Entering the New England Telephone and Telegraph Company as assistant manager he was six years ago appointed superintendent of the central division of the company with headquarters in Lowell.

GEN. EDWARD B. FOWLER.

Gen. Edward B. Fowler, the war Colonel of the "fighting" Fourteenth Regiment, died on Jan. 16 at his home in Brooklyn. He was prostrated with paralysis about three months ago, and from the beginning of his illness there has been no hope of his recovery.

Gen. Fowler belonged to an old English family which settled at Hempstead, L. I., over a hundred years ago. He was born in New York City in 1827 and when a boy moved to Brooklyn with his parents. While still attending school he joined a youthful patriotic corps known as the "Union Blues." Two years later, when the Fourteenth Regiment was organized, he joined it with the rank of Lieutenant. His promotion was rapid, and when the war broke out he held the position of Lieutenant-Colonel. He was with the "Fighting Fourteenth" all through the war. He assumed command of the regiment at the second battle of Bull Run, and led it with conspicuous bravery in the many engagements in which it participated. His "red-legged devils" and their brilliant deeds are one of the glorious memories of the war.

He was twice severely wounded, but did not return home

GEN. EDWARD B. FOWLER.

until the regiment was mustered out of the service on June 6, 1864, when he retired with the rank of brevet Brigadier General. He resigned the command of the regiment in 1866, but until recently had been President of the War Veterans' Association of the regiment.

Soon after the close of the war Gen. Fowler was given a responsible place in the Custom House, and held it a long time. Subsequently he was connected with several banks, chief clerk of the Brooklyn Board of Audit, Treasurer of the Atlantic and Pacific Telegraph Company, and chief clerk in the Internal Revenue Department in Brooklyn. He was auditor of the Commercial Cable Company at the time of his death. Gen. Fowler was always an ardent Republican.

The deceased leaves a widow, a daughter, Mrs. W. H. Baker, wife of the vice-president of the Postal Telegraph Co., and a son, Edward Fowler.

The funeral services were held on Sunday afternoon in the Simpson Methodist Episcopal Church, after the body had lain in state in the Brooklyn City Hall. Among the pallbearers were Gen. B. F. Tracy, Gen. John B. Woodward, Gen. Butterfield, Gen. McLeer, Gen. Theodore B. Gates, the Hon. Seth Low, Mr. A. B. Chandler and Mr. George G. Ward. We are indebted to Mr. J. B. Tattavall, of the *Telegraph Age*, for the excellent portrait herewith.

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CONTENTS.

PHOTOGRAPHY THROUGH OPAQUE BODIES.

WORLDWIDE attention has been aroused by the reports of the work done by Prof. Rontgen in taking photographs electrically of articles screened by solid objects. In our present issue we print an article by Mr. Georges d'Infreville, the well known electrical engineer and inventor, in which he advances what we may perhaps call his claims to priority in this respect; and in which he also makes some remarkable statements as to the ability to see electrically in darkness. We are sorry that Mr. d'Infreville is not at liberty to go into further details, but we are constrained to say that in this article he makes no assertion that he has not been making, confidentially, for a long time past—to our knowledge, for many months. This seems to us to be another of those instances where a good many people are working on one line, and are greatly surprised or even mortified to learn, from a sudden disclosure, that they have not got the field entirely to themselves. Mr. d'Infreville and the others working upon the subject of "phosphotography" and "phosphorescent" or "etheric" lighting in general, have our heartiest good wishes for an early fruition of all their hopes and dreams.

THE INSTITUTE 1,000 STRONG.

IT is with no small pleasure that we record the fact that within the present month the Institute has reached a membership 1,000 strong. This result has been accomplished in less than 12 years, and represents normal healthy growth throughout the last 10. They who have labored for the welfare of the Institute, and have borne the burden and heat of the day, have certainly much to encourage them in such a showing and also in the useful, dignified position of the Institute to-day.

Still, there is much that remains to be done, and some ideas for the future are suggested by the action of the American Society of Civil Engineers at its annual meeting last week. For many years past, that Society has owned and occupied a fine house on Twenty-Third Street, but it has now reached a membership of 2,000 and has thus outgrown its quarters. Under these circumstances, the Society has bought real estate at Broadway and Eighth Avenue (Fifty-ninth Street and Central Park) and will erect a $400,000 building which is to embody the latest beauties of architecture as well as the latest facilities for library, museum, &c. It seems to us that such a move brings up again the old project for closer engineering union and co-operation. Only in such a fireproof structure standing apart can a library and museum be properly kept; and neither the old house of the Civil Engineers nor the newer house of the Mechanicals is fit or safe as a repository for the treasures and relics rapidly accumulating. In the case of the Electricals, they have dodged from pillar to post, have shared the hospitality of both of the other societies, and now have a small niche in the cock loft of the Havemeyer Building, where things are very comfortable but by no means stately.

Until the conditions are inviting, the Institute will not receive the many donations of books and papers intended for it nor will it be made the custodian of the large variety of electrical relics and models that should properly be in

its care and keeping. We see no good reason, therefore, why the Institute should not endeavor to meet the other societies at this juncture in an endeavor to put up a building worthy of all and able to accommodate all. The opportunity is so good, we should be very sorry if no effort is made to benefit by it. As times grow better, members will be able to assist in the work by their liberality, but even on a plain business basis the various bodies of engineers should be able to secure a central union building which is at once a home, a museum, a library, and a safe deposit for the property and publications of them all.

SLOW SPEED DIRECT-CONNECTED ENGINES.

THE last five years have witnessed a remarkable growth in the application of direct connected engines to the driving of dynamos both large and small; and in the latter case particularly, direct driving has become somewhat of a fad. Not all engineers, indeed, are agreed upon the superiority of small direct connected units and many are still of the opinion that the belt-driven dynamo running at 1,000 revolutions or thereabout has been unnecessarily crowded into the background. Engine builders, also, have not all entered the field of direct driving voluntarily and in many cases may be said to have been pushed to it by the desire to meet a demand created largely by competition. Those who favor belt driving argue, not without some reason, that the direct-connected unit forces both the steam engine builder and the dynamo constructor to adopt methods which militate against either the cost or the efficiency of their respective apparatuses in order to adapt them to each other; as a result a reaction is already beginning to be noticeable, looking to a lessening of the difference in speed requirements. A most most notable example of this kind is the type of geared engine designed by Mr. Elmer A. Sperry, which is described elsewhere in this issue. With the arrangement there adopted, a ratio of two to one is obtainable between the speed of dynamo and engine, a decided gain, as it permits of the employment of a slower speed engine or a higher speed dynamo or a combination of both, as compared with present direct connected practice. The last word on dynamo driving has by no means been said, and the progress of Mr. Sperry's method will be watched with keen interest by electrical engineers.

ELECTRIC TRACTION ON THE ERIE CANAL.

ONE of the most interesting as well as important public documents recently coming under our notice is the report of State Electrician C. R. Barnes, containing the results of experiments on canal boat traction carried out with the Lamb towing system at Tonawanda, as recently described in our columns. These experiments were carried out with a scow having a displacement of 217½ tons and drawing 5½ feet of water, the run being made over a distance of 2,145 feet or 0.4062 mile. Notwithstanding the fact that the vessel used was a scow, which for a given displacement offers more resistance than an ordinary canal boat, and also that the motor employed was only taxed to one-third of its rated capacity and that its efficiency was still further impaired by fluctuation in the potential of the railway current during the test, an average speed of about 2½ miles per hour was obtained, with the expenditure of only 8½ electrical horse power. With these figures as a basis Mr. Barnes shows that at the price at which the Erie Canal Traction Co. is bound by virtue of its franchise to furnish electric power to boatmen, namely, not to exceed $20 per H. P. per season of navigation, with a boat making 35 single trips between Buffalo and Troy, the cost per trip at the speed referred to would be less than $5.00 or 1.4 cents per mile. Assuming that during one-third of the entire time the motor remained idle at the locks and elsewhere, although power was charged for just the same, the cost per boat mile covered would average 2.1 cents or $7.66 per trip. Still further, adding a rental charge for the motor, the total cost would amount to 4.2 cents per mile or $15.32 a trip. Mr. Barnes considers this estimate a very conservative one, and believes that at this rate not only would power be cheaper to the consumer, but the renting out of motors would prove a profitable enterprise. He also shows that if it were desirable to run at the speed of 3½ miles instead of 2½ miles per hour, the power would be increased from 8½ to about 23.4 electric H. P., which would make the cost 8$\frac{2}{10}$ cents per mile, or $29.93 per trip. It must be borne in mind that all these calculations are based as a result of the first test of the system. There is very little doubt that when the apparatus has been thoroughly adapted to its work these figures will show a decided reduction, but even as they stand they are a sufficient indication to warrant the belief that electric canal boat towing on the Erie canal for its entire length is now only a question of a comparatively short space of time.

MODERN APPARATUS vs. EXISTING CONDITIONS.

UNDER the above title Mr. W. J. Buckley in a paper read before the Northwestern Electrical Association, printed elsewhere in this issue, has brought together a number of home truths which we earnestly recommend to the attention of every central station manager. Mr. Buckley has done well to give particular prominence to the Welsbach burner and its influence on the income of lighting stations, for there is no subject now more seriously engaging the attention of many central station managers than the combating of this new foe to dividends. Mr. Buckley suggests various expedients for counteracting the influence of the Welsbach, such as a cut in rates, the application of incandescent lamps ranging from 100 to 500 candle power, or, if necessary, the buying up of, or selling out to, the gas company. There may be virtue in either or all of these suggested remedies, but we think the keynote is struck in Mr. Buckley's suggestion that the incandescent lamps be increased to a "competitive brilliancy." Mr. Buckley evidently implies thereby the raising of the candle power beyond the normal and justifies this expedient by the present comparatively low cost of incandescent lamps. As an expedient, pure and simple, we have no fault to find with the suggestion, but does it not imply a pre-existing weakness in any system that compels the adoption of a temporary measure of this nature? Mr. Buckley says with much truth, that the public are willing to pay one-fourth to one-half more for electric light than for gas, *provided they get full candle power*, and herein, we think, lies the key to the whole situation. If instead of giving the candle power of lamps a temporary "boost" during a limited period of time, the practice be adopted of renewing all lamps as soon as they fall below, say, 12 candle power, neither the Welsbach nor any other type of gas-light thus far presented to the public could successfully compete with the incandescent lamp. Careful station managers have long since recognized this fact, and in the best paying stations lamps are renewed free as often as the customer calls for them; while in not a few instances the companies themselves make regular periodic inspections and without solicitation renew defective lamps. All this appears so axiomatic as a factor in successful central station management as scarcely to require pointing out at this late day, with lamps selling at 18 cents apiece; but we are convinced that the losses of nonpaying stations will on examination be found to bear a direct ratio to the candle power of the lamps on their circuits. It may still require time to bring home the lesson of "full candle-power" to the rank and file, but until that becomes the goal to be striven for, dividends may have to wait on assessments.

Mechanical.

THE SPERRY SLOW SPEED ENGINE FOR DIRECT DRIVING.

It is probably not beyond the bounds of truth to say that no industry has had a greater influence on stationary steam engineering than electric generation and distribution. From the Edison Jumbo, to belting and later back again to direct connection, all served to show the changes which a new industry can bring about within a comparatively short time. But notwithstanding the present popularity of the direct connected high speed engine there are some who believe that better results can be attained with engines moving at slower speed with Corliss valve gear, and which are not subject to the wear and tear of high speed engines. Thus far the belt has been the only means by which this seems possible, but in a recent patent Mr. Elmer A. Sperry shows a type of engine which is so designed that a comparatively slow-moving piston in connection with a Corliss valve gear can without change of stroke or other relations employed with the highest economies, be made to give double the rotative speed as compared with engines coupled in the ordinary manner. This allows electric generators to be built of only half the size, weight and cost of those now required for a given service at the speeds in vogue at present. The manner in which Mr. Sperry has carried out this design is shown in Fig. 1, which illustrates his new type of engine, while Fig. 3 shows an enlarged view of its principal operating parts.

As will be seen, the reciprocation of the piston is transformed into rotary motion of the crank through the oscillation of the articulating-links, the axis of the crank-shaft lying practically in the projection of the middle line of the oscillation of the links. One of the links being anchored at the fulcrum or gudgeon, the free end of the other link vibrates to and from this gudgeon and hence turns the crank by this vibration, which occurs twice for every single oscillation of the links. The free end being connected to the crank by the pitman the crank-shaft is given two revolutions for each double stroke of the piston, and at the same time the length of the stroke of the pitman and piston may be held on an equality or may be made to vary in any desired ratio to each other. When these ratios are equal, the strength of the parts—for instance, the crank-shaft, pillow-block, crank-pin, pitman, etc.—need not be materially altered from the best practice in the ordinary type of engine. This, it will readily be understood, would not be the case if, for instance, the piston was attached to the oscillating links at their articulating-point. In this case the strokes of the pitman for anything like the best distribution of strains would have to be far less than the length of the stroke of the piston, and would therefore have to be made very much heavier for an engine of a given piston-speed, and furthermore the limitation which by far is the greatest in present engines would in no wise be overcome, but would on the other hand be aggravated. The attachment of the piston to a point on the lever intermediate between the fulcrum and the articulating-point or any method with the arrangement shown whereby the stroke-lengths of the pitman and piston may if required be rendered equal and allowed to vary from this point either way, is considered by Mr. Sperry to be one of the essential parts of the system.

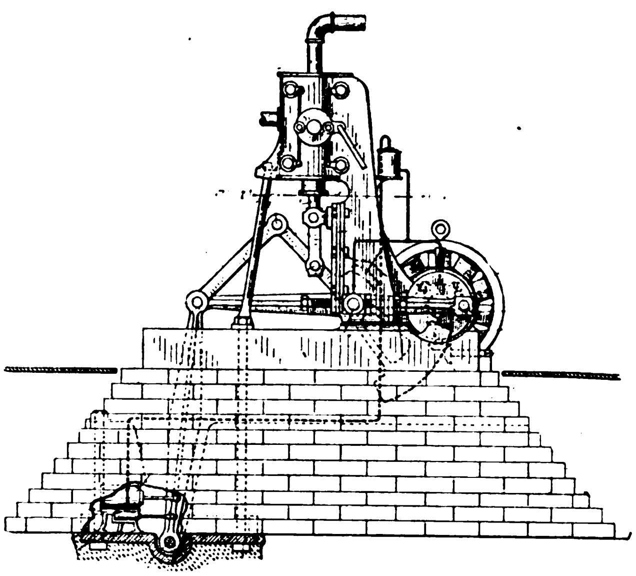
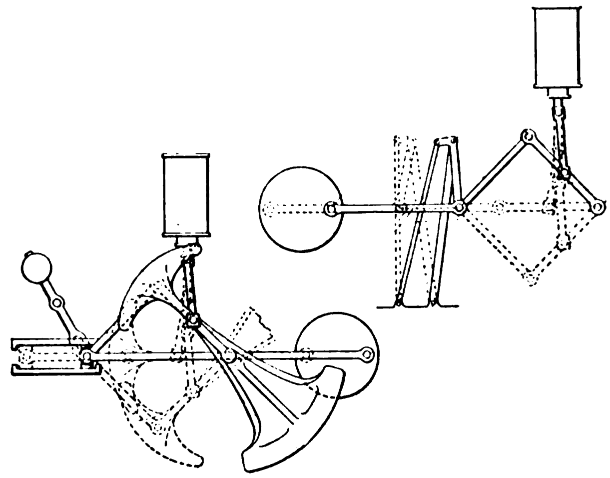


Fig. 1.—The Sperry Slow Speed Engine for Direct Driving.



Figs. 2 and 3.

To illustrate the function of the masses and counterweights attached to and forming a part of the oscillating or reciprocating elements, Mr. Sperry takes a case of a 400 H. P. engine making one hundred double strokes of the piston and two hundred revolutions of the crank-shaft. The articulating-point between the lever and the link, Fig. 2, will be found to attain a velocity of about fifty-two feet per second crossing the centre line of its oscillation—that is, in half a stroke it has attained approximately this velocity. It has been found that the weight of the vibrating masses should be such that at this central point they will have absorbed in their acceleration a considerable percentage of the energy delivered from the source of power. This should for most instances exceed thirty to fifty per cent. of the power. With high velocities light parts will fulfill these requirements. It may be with advantage increased considerably beyond this point, but should not be decreased very much below it, although farther experience may lead to a wider variation for special purposes.

In the case cited one ton at this point may be made to absorb 165.6 horse-power seconds. The energy stored up in the moving masses at this point is delivered by them to the pitman and crank-shaft in the last half of the stroke. In this region the pressures due to early cut-off, expansion of steam or other causes would otherwise be materially lessened, the advantage of this arrangement being a very even distribution of the pressures on the crank-pin through both halves of each stroke. The increase in weight of the oscillating mass furthermore tends to neutralize the lunge or tendency to pound and to give a more uniform movement while passing the centre of oscillation, at which point the strains are reversed. Both these points have been found essential and necessary, not only to smooth running but for economical construction.

Telephony and Telegraphy.

SCRIBNER'S METHOD OF AVOIDING SIDE TONES IN TELEPHONE TRANSMITTERS.

As is well known, the telephone-receiver at a station is included in circuit with the secondary helix of an induction-coil whose primary helix is in the circuit of the microphone at the same station, so that disturbances or vibrations of the microphone are reproduced in its own telephone-receiver, such sounds being designated "side tones." The side tones may be either noises arising from accidental vibration or jarring of the microphone or the vocal sounds spoken by the user of the microphone. The noises produced by the jarring of a powerful transmitter

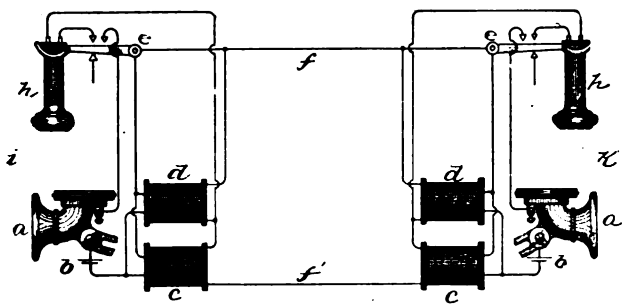


Fig. 1.

are frequently sufficiently loud to mask or obscure the articulate sounds reproduced in the receiver when it is in use, while the sounds reproduced in the receiver during the use of the corresponding microphone are so loud as to make the close application of the telephone to the ear unpleasant or injurious, while if the receiver be momentarily removed to avoid the loud sound the reply from the distant station may be lost. To avoid this inconvenience, Mr. C. E. Scribner, the well-known inventor of Chicago, has designed the arrangement illustrated in Fig. 1 and shown diagramatically in Fig. 2. The microphone *a* is included in a local circuit with the battery *b* and with the primary helices *c′* and *d′* of two induction-coils *c* and *d*

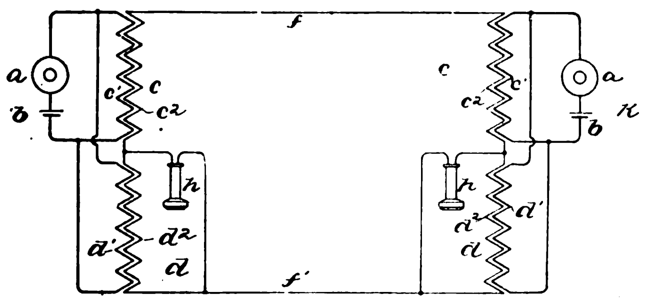


Fig. 2.

the primary helices being placed in parallel branches of the local circuit.

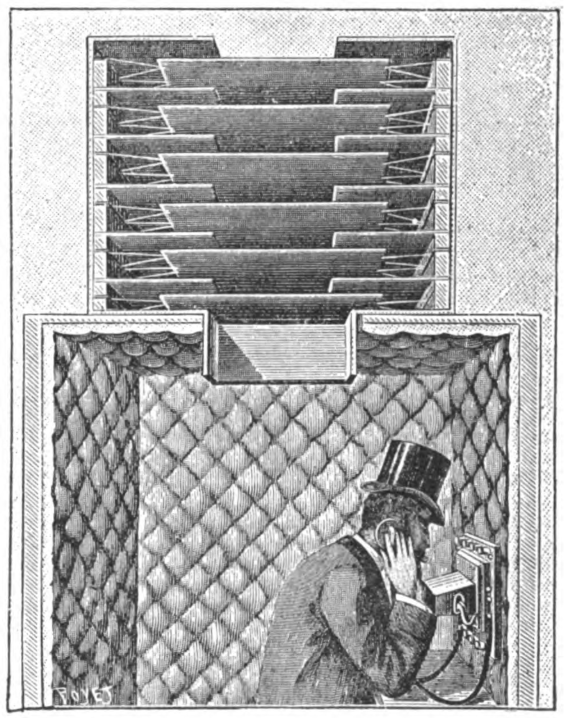
As seen in Fig. 1, the microphone-circuit is connected with the contact-points of a telephone-switch *e* by which it is closed when the telephone is removed from the switch-hook, in the usual way. The secondary helices c^2 and d^2 of the induction-coils *c* and *d* are connected in series in the line-circuit *f f′*. The telephone-receiver *h* is placed in a branch of the line-circuit in parallel with the secondary helix d^2. The connections of the primary circuits with the local circuit are so made that undulatory currents through the primary helices *c′ d′* induce currents in their respective secondary helices c^2 d^2 in the same direction in the line-circuit, as indicated by the arrows in Fig. 2.

The mutual inductions between the primary and secondary helices of the respective induction-coils *c* and *d* are so adjusted that with a given resistance in the line *f f′* no difference of potential exists between the terminals of the secondary helix d^2 while undulatory current is circulating in the primary circuit. Under this condition no current will flow through the telephone-receiver *h*, and hence no side tone will be produced therein. The coil d^2 thus produces no useful current in the line-circuit, but contributes only sufficient electromotive force to overcome its own resistance, thus permitting the helix c^2 of the induction-coil *c* to impress its full electromotive force upon the line-circuit *f f′*, creating current through the instruments at the distant or receiving station.

The secondary helix d^2 is made of high impedance, by making it of many turns of fine wire and placing in its field a considerable mass of iron, the effect of the high impedance being to prevent any considerable portion of the rapidly-changing telephonic currents flowing from a distant station through the line-circuit *f f′* from being shunted from the telephone-receiver *h* through the helix d^2.

THE MENIER VENTILATED TELEPHONE BOOTH.

Telephone booths, as is well known, are constructed so as to deaden the sound, in order to prevent the conversation from being heard on the outside. The means employed to effect this purpose have in the past given rise to much discomfort, by the absolute lack of ventilation which becomes noticeable, even after but a few minutes' sojourn in one of these booths. Our readers will, therefore, be interested in a very novel device, devised by Mr. H. Menier, of Paris, which we illustrate in the accompanying engraving, taken from *La Nature*, the object of



The Menier Ventilated Telephone Booth.

which is to afford complete secrecy for the telephonic communication, while at the same time permitting of the ventilation of the booth.

As is shown in the accompanying illustration, the top of the booth has a large opening, over which is placed a box open at both ends. Within this box are placed, at regular intervals, thin boards covered with cloth, let into the sides of the box, with openings of the same size as the hole in the roof of the booth. Other thin boards, also covered with cloth, are supported by cords from the sides of the

box, and are placed between the boards above mentioned, which are attached to the sides of the box. This arrangement allows the free circulation of air from the top of the booth, while experience has shown that it shuts in all sound.

In order to assure himself of the latter condition, Mr. Menier installed an apparatus of this kind over an opening in the wall, separating two rooms, and it was found that two persons, one in each room, placed one metre from either end of the sound deadening box were not able to converse, even in a loud tone of voice.

ELECTROLYSIS OF PITTSBURGH TELEPHONE CABLES.

A special dispatch from Pittsburgh of Jan. 13 says:—Every underground cable in Alleghany City, all underground wires in Bellefield, and part of the system of East Liberty and of the West End, have been abandoned, the down town district practically being the only part of the system in the two cities that has escaped the ravages of electrolysis. The wires affected are the property of the Central District and Printing Telegraph Company, otherwise known as the local telephone company. The wires had recently been placed underground at a cost exceeding $50,000. The water companies, telegraph companies, electric light companies, natural and artificial gas companies have also suffered to a large extent.

TYPICAL NEW YORK TELEPHONE LEGISLATION.

The usual fight against telephone corporations of New York State has begun in the Legislature. Assemblyman Cain of Brooklyn has introduced a bill creating a State commission to consist of the Comptroller, Attorney General and the State Engineer and Surveyor, who are to meet at Albany once a month and investigate all complaints by or against telephone companies and make rules and orders for the carrying out of the law. They may employ a stenographer at a salary of $2,000 and may hire expert accountants to examine the books of telephone corporations. The entire expenses of the commission shall be paid by the telephone corporations, in the same manner as the expenses of the Railroad Commission are paid by the railroad corporations. Telephone corporations are required under the bill to make an annual sworn statement, upon blanks furnished by the commission, of their receipts and disbursements for the year. The charges to subscribers, which are intended to be of such a nature as to net the companies a profit of at least 10 per cent. upon their capital stock, are as follows: Cities of 1,000,000 or over, $85 a year; cities of 500,000, $75; cities of 100,000, $48; cities of 20,000, $36; places of 8,000, $30; all other places, $27. Charge at pay stations, 10 cents for the first five minutes, and 5 cents for each five minutes after, for local distances.

What was known last year as the "Gerst telephone bill," which regulated the charges in all cities, was similar to this bill except that the charges in the Cain bill are about $12 a year higher.

THE HARRISON TELEPHONE CO. IN DUBUQUE, IA.

A special dispatch from Dubuque, of Jan. 8 says:—The Harrison Telephone company that started to establish an exchange in this city some time ago got the worst blow in a Kansas City justice court that it has yet received anywhere. A stock broker of that city had stock of a face value of $20,000. He sold it for $200 cash. The man he sold it to brought action against him for obtaining money under false pretenses. The justice reserved his decision. If he finds that the stock is worth even 1 cent on the dollar the defendant will be released. The company still seems to have a nominal existence, but it begins to look now as though all the millions of stock it issued would be of greater value if the paper on which the shares are printed were blank.

Mr. A. W. Prior has resigned the position of manager of the Macon Telephone exchange. He will go to Pennsylvania to engage in the manufacture of electrical apparatus.

Providence, R. I.—In addition to its fine new exchange, illustrated in The Electrical Engineer last week, the Providence Telephone Co. is putting up a building at Pawtucket for its own exclusive use, to be one story in height, and to be fireproof in every respect.

OUR "NEW YORK EDISON" ARTICLE.

Mr. Chas. L. Clarke, writing of The Electrical Engineer of Jan. 8, and its description of the New York Edison stations says:—"It looks like one of the most complete articles on a commercial electric light and power plant, in its technical and business aspects, that has ever been published. I like its direct and simple style. It appeals to me as a practical engineer."

MISCELLANEOUS.

CONCENTRIC WIRING.[1]—II.

BY SAM. MAVOR.

There is a steadily growing dissatisfaction with the generally adopted practice of enclosing the conductors in wood casings, and a steadily growing conviction that something better might be done. In most factories and warehouses it is possible to have the casings laid upon the surface, but in dwelling-houses, or in good hotels or clubs it should not be tolerated. Everyone is familiar with the unsightly wood casings and clumsy crockery ware which disfigures so many of the best hotels and other buildings in this country. How often we hear that electric light is not adopted because of the dread of the wood casings, and the cutting about and disturbance which their erection involves! Those casings are a standing reproach to the people who erect them. One has only to see the interior of a good building which a contractor has dared to wire on the prescribed lines with wood casing to realize how utterly unsatisfactory is the system. Those hideous casings are entirely out of harmony with their surroundings, and offend the eye at every turn. They blunder across ceilings and cornices, intrude upon decorative panels, and push their ruthless way through frieze and dado; while out of sight beneath the floors the joists are cut away to clear the casings until the margin of strength is often perilously low. The truth of the matter—and we all know it—is that we cannot carry out the wiring of, for example, a private residence in compliance with the recognized rules for double wiring and wood casing without excessive cutting of floors and plaster work, and disfigurement of walls and ceilings. At every turn we have to compromise between the decorations of the house and the fire insurance rules, and the concessions must needs be generally in favor of the decorations. In short, the modifications of the rules require to be so many and important that this system of wood casing is one which cannot be consistently and thoroughly carried out.

When the usual double wiring is carried out in situations where moisture charged with acid from cemented or plastered walls of interiors, or in such buildings as paper mills, wet spinning mills, dye houses, breweries, distilleries, chemical works, and the like, the destruction of the insulation is only a matter of time, and the casing, by harboring the moisture around the conductors, hastens the process. After the insulation has broken down, electrolysis, assisted by the acidulated moisture, takes place, and deposits away the copper of one of the conductors, with the consequent risk of heating and ultimately of sparking. The presence of moisture being a necessary condition of the development of such faults, the dampness of the surroundings of the conductors greatly reduces the danger of fire, but that the risk is not absent is proved by the charred and burned casing or woodwork found at such places. It must be remembered, however, that heating due to diminished section of the conductor may occur at a time when the moisture which caused the fault has disappeared, and this is a danger which no amount of fuses will modify. How can you ensure that your woodcased conductors shall never be subjected to such conditions? And how many of your average wireman's joints would stand 24 hours' immersion in water or soaking in moisture? The miserably futile expedient of attempting to waterproof the casings with putty and varnish is sometimes resorted to; such makeshifts are too childish. Lead-covered conductors are occasionally used where much moisture has to be encountered. But these for double wiring are a mistake, unless the positive and negative wires are both enclosed in the same lead sheathing. The objection to separate lead-covered conductors is that, if there should be an earth or leak on the negative wire, and the lead and insulation of the positive wire becomes punctured at a damp situation, the lead becomes charged positively, and will be deposited away over its whole length where moisture is present to assist electrolysis. This remark has no application to lead-covered conductors on board ship, where the lead sheathing is throughout in intimate contact with the hull of the ship, nor to lead-covered concentric conductors. This liability to injury from moisture is the fatal weakness of the ordinary wood-cased system. It is of much greater consequence to obtain a moderately high insulation, which may be relied upon to be durable, than to have—as can easily be had in a dry building—an insulation resistance of many megohms, which will disappear on the approach of the charwoman and her wash-bucket, or is at the mercy of the first loose slate or leaky water-pipe. What a common experience it is to discover wiring faults in the fungus-grown casings in damp and mouldy basements, or upon the "sweating" surfaces of cemented walls or ceilings! A fault which developed a few weeks ago in the writer's office is a good illustration of the weakness of the present double-wiring practice. The walls are covered with a light-green paper, which on one side of the room is pasted to a wooden partition, and through this partition and paper the conductors are led to a switch. Behind the base of this switch sparking was observed. On examination it was found that in our humid

climate the paper had absorbed moisture from the atmosphere, and this moisture, charged with an acid held in the paper, had attacked and destroyed, first the insulation of the conductors, and then the copper, until of the latter only a green sulphate remained, and the circuit was interrupted. As only one lamp was in circuit the spark was small and the heating effect slight, but under other conditions the results might have been serious. This is an interesting example of a fault developing in an apparently dry and well-aired and warmed room, and under the eyes of one whose business it is to avoid such faults, and to whom a spark was the first intimation of anything being wrong.

After wood casing, with its perviousness to moisture and other attendant disadvantages, the biggest blot on existing practice is the indiscriminate use of fuses. Some insurance people, and wiring contractors too, imagine that the risk of fire varies inversely as the number of fuses. The contrary is more near the truth. Fuses are not only a nuisance, they are apt to be a positive source of danger. The smaller number of fuses used the better; but they must be absolutely reliable, well mounted, and well placed. Most of the leading wiring contractors have adopted the distributing box plan of wiring, in which the branch fuses are grouped at the distributing centres. This system should now be compulsory. The use of isolated fuses should be strictly prohibited. The only inducement to use them is a trifling saving in the cost of conductors. The number of fuses should be kept down by keeping up the section of conductors. The larger expenditure on branch conductors entailed is amply repaid by the simplicity and uniformity secured. The dangers of diminishing the section of conductors and scattering fuses through a building are that the crockery fuse bases and cases are liable to breakage; the terminal screws are liable to become loose and so cause heating; and last, but most important, the danger of a conductor of too large area being used by an inexperienced or careless person instead of a *bona-fide* fuse, in which case the "fuse" is a delusion. This last danger is so real and so imminent that the insurance companies ought long ago to have prohibed the use of such fuses. The writer was recently in competition with a firm of contractors of large experience who do a great amount of wiring, and were in this case estimating for wiring about 200 lamps of 16 C. P. each. Samples of the conductors, &c., quoted for were invited along with the estimates, and our double-wiring friends submitted a sample of each of the *nine* sizes of insulated cables and wires, with their corresponding wood casings, and of each of the several sizes of fuses which they proposed to use. Nine different sizes of cables and wires were certainly not essential to the double wiring of this building, but they were part of the method of a much-experienced contractor, and his method is common to many others.

MODERN APPARATUS vs. EXISTING CONDITIONS.[1]

BY W. J. BUCKLEY.

Two things are constantly changing the conditions of your various plants, namely: the development of new apparatus, and the reduction in price of supplies. The money earning station fits its apparatus to its service; not the service to the apparatus. If you charge $10 a month for a 2,000 candle power arc lamp and your customer regards you as a robber, it would seem expedient to furnish either a smaller arc, or a big incandescent lamp service at meter rates, thus reducing the price, but not the proportionate profit. A big cut in your 2,000 candle power rates will transform that service into a non-paying investment, while a service of half the candle power at half the cost of production, will pay a profit.

The big incandescent lamp is a money making factor ignored by a majority of operating stations, either through lack of knowledge or appreciation of the fact that efficient 100 to 500 candle power lamps are selling at a price that commends their use.

Unless you are running a modern plant, it costs $6 per month to produce and maintain a 2,000 candle power arc lamp. This applies to the average station, and will be believed by the stockholder who has been in business long enough to see his intended investment enlarged, his plant rebuilt and his prospective profits used up long before they reach him in the form of a cash return, in expenditures necessary to meet unlooked for changes or unwelcome competition.

One of the chief elements of the latter is the Welsbach burner. This competition you have met in your various ways; yet you are all doubtless impressed with the fact that it has come to stay; not perhaps in its present form, but in a new and improved burner which eliminates some of the many glaring faults of the original. The quicker this competition is met, the easier and cheaper it is overcome. But how? Many men of many minds would have as many answers. The president of the Calumet Gas Company, of Chicago operating the second largest arc plant in this country, thinks the strongest competing service is an arc system in "blocks of five;" 500 candle power arc lamps, $\frac{5}{8}$ carbons, $5 per month, 5 per cent. discount when paid within five days after the first of the month.

1. Abstract of a paper read before the Northwestern Electrical Association, Milwaukee, Jan. 15-17, 1896.

In this consideration we may assume, first, it is unnecessary to bodily buy the Gas Company; or secondly sell your holdings at a sacrifice. If you can sell at a price and will not, we take it that you are running your station for the sake of your health, in which event, the Welsbach burner becomes a mere diversion breaking the monotony of an otherwise peaceful life.

The Welsbach fad strikes a town over night and goes through it like a dose of measles. It lasts about nine months, will usually displace one-third of your lamps in service, which, owing to the many objections of the burner, developed in its use, gradually return like lost sheep to the fold until the former output is reached, if not passed, by the demand created for a more liberal illumination.

The first change found necessary in your operation is to increase the candle power of your lamps to a competitive brilliancy. When 16 C. P. lamps sold at 85 cents this might prove disastrous, but with better lamps at 18 cents apiece, it becomes a necessary virtue. This will not decrease your profits as much as your first thought might suggest, for the increased voltage will run your meters fast enough to make up the added expense, provided you sell your current through meters. If you do not do so, the added revenues of those who do, would suggest that you climb in the band wagon and buy meters for your entire equipment. It is a money earning proposition to you and the satisfaction to your customer, who is pleased with his daily inspection of current used, even if the meter is 25 per cent. too busy.

In this connection the advisability of accurate switchboard instruments and their periodical calibration with a standardized instrument is clearly shown; as a comparison of the station output with the receipts, will immediately uncover any leakage in the revenue.

The increasing of your pressure will disclose, if your experience has not already proved it, the inefficiency of small transformers of any make. The ground losses on the line and the copper and iron losses in the transformers of the ordinary alternating station are uselessly and unnecessarily large. Four out of seven stations tested by me in the past three months for their constant load loss, have shown that less than two-thirds of the current generated reached the lamps. One station employing a 90 K. W. 1,800 light 1,000 volt alternator with 1,842 lamps wired, gave an output of 70 amperes at the switchboard when 840 lamps were burning. The lamps, which were all of one make, were counted between the hours of seven and eight P. M. when the customers were requested not to turn off or on any lamps in that interval. The test showed that current for 1,400 lamps had been generated at the station with a constant load loss of 28 amperes. This loss should not exceed 8 amperes. The current at the switchboard running 840 lamps should have registered as 50 amperes, all of which would indicate that this station ran with a constant load loss of 20 amperes, or current enough to supply 400, 16 C. P. lamps, for which the station received no pay. This useless loss was eliminated by putting triple petticoat porcelain insulators in place of the single petticoat S. G. glass; removing one fixed and one intermittent ground on the line and changing 1,400 lights of 5, 10 and 25 light 50-volt transformers to 2, 250-light, eight 100-light and two 50-light 100-volt transformers. The balance of 400 lights were on the residence circuit and were changed from 50 to 100 volt without materially decreasing the size of the transformers. When these changes were completed, the output at the switchboard was 51 amperes with 898 lamps burning. While formerly most of the output was sold at a given rate per lamp per month when the change was made, every lamp was put on meter, and a losing station converted into a paying property.

Increasing the candle power will apply to the same extent in meeting ordinary gas competition. We know the public is willing to pay a fourth to a half more for electric light than gas, provided they get full candle power. Taking gas and incandescent lamps at equal candle power, the equivalent rates would be as follows:

Gas	at	$1.00	per	thousand	equals	16 C. P.	lamps	at	½c. per hour.
"	"	1 50	"	"	"	"	"	"	¾c. " "
"	"	2.00	"	"	"	"	"	"	1c. " "

This presumption will certainly leave a fair margin of profits on a competitive basis, as the life of the incandescent lamp cuts but one fifth the figure it did four years ago. The pioneer usually forgets this change in lamp values, and through force of habit and training keeps down the incandescent candle power. A new rule hung on the switchboard should read "Keep up the Candle Power to Keep Your Job."

The following efficiencies of 100-volt 16 C. P. lamps is the result of a test made with some of the prominent makes:

Thomson-Houston	consuming	.62	amp.	or 62	watts	gives	3.875	watts	per C. P.
Edison	"	.55	"	" 55	"	"	3 437	"	"
Buckeye	"	.56	"	" 56	"	"	3 500	"	"
Packard	"	.57	"	" 57	"	"	3.562	"	"
Bernstein	"	.65	"	" 65	"	"	4.062	"	"
Beacon	"	.54	"	" 54	"	"	3.375	"	"
American	"	.58	"	" 58	"	"	3.625	"	"
Columbia	"	.61	"	" 61	"	"	3.800	"	"
Keystone	"	.56	"	" 56	"	"	3.500	"	"

The price delivered and the guaranteed life are other points which decide the preference, but I hesitate to include the life test through a dislike of a probable criticism of advertising some particular lamp; and again each batch of lamps filling a given order from almost any maker seems to vary from the average life of the preceding lot.

The "New Lamp," like the "New Woman," will curtail the material used in its construction and produce more effect with a given energy. A lamp having a life of 500 hours and taking $2\frac{1}{4}$ watts per candle-power at 18 cents apiece, or still better, a 300 hour 2-watt lamp will greatly increase our competitive strength.

The contingency arising from an opposition plant entering your field with neither your permission nor pleasure is, of course, governed by local conditions and your judgment.

Referring again to the Calumet Gas Co. as a successful fighter of competing plants, I will state that this Company has but one rule: fight from the shoulder. Drop the prices down at one stroke to a point where the other fellow must lose. Deprive him of all revenue and he is forced to quit. This rule has placed the price of 1,200 C. P. arc service in certain districts in Chicago at 10 cents per night, $2.60 a month.

It may be expedient to state that the Calumet Gas Co. has money and a modern plant. If you have neither, the value of fighting from the jump is not altered, as it forces you to draw on other resources to modernize your station, a good thing in itself, or without resources it compels a more liberal and immediate purchase of your plant.

To-day, power, arc and incandescent service, is produced from the same machine and any agreement to divide the service is liable to daily abrogation. The best protection to the value of your property and its revenue, is to keep it modernized. This contemplates a continuous expenditure anticipated and met by the money earning plants.

The development of the business has demonstrated the economy of large units. In arc service the 100 to 125 light machines have displaced the 35 to 50-light units with a saving in maintenance of 40 per cent. In direct current service, the large units effect a saving in maintenance of 20 per cent., which is increased up to 50 per cent. by being direct connected. In alternating current service, the large units effect a less apparent saving in current efficiency; but the slower speed, lower temperature, and ability to run continuously makes their adoption a commercial gain, apart from the simplification of circuits.

Speed and weight should govern the price of all types. A dynamo running at 600 revolutions weighs nearly twice as much as one of the same design and rated capacity at 1200 revolutions. It costs 70 per cent. more to build. Hence, a direct connected dynamo at 275 revolutions is worth 70 per cent. more than a belt driven machine of the same design at 550 revolutions. When the armature is built directly on the extension of the ordinary engine shaft, this may be reduced to 50 per cent. on account of the doing away with one box, pedestal and part of the frame.

Suppose a purchaser wants a direct current belted machine of 100 H. P. or 1000 lights capacity. He finds the cheapest type, a bipolar machine, say with a speed of 1200 revolutions, weight 6000 lbs., price $900, average efficiency 80 per cent., with an armature life of two years if loaded. In the multipolar machine he finds the high speed belted dynamo at 1,100 revolutions, weight 6,500 lbs., price $1,000, same efficiency and life as bipolar. The medium speed dynamo at 550 revolutions, weight 11,000 lbs., price $1,400, 85 per cent. efficiency, armature life five years. The slow speed 275 revolutions, weight 17,000 lbs., price $2,200, 87 per cent. efficiency, armature life eight years.

Thus we have dynamos of the same make, if you will, and each of the same rated capacity in horse power, lamps or kilowatts ranging from $900 to $2,200 in price; the more expensive machines not always receiving at your hands the consideration they deserve. The dimensions of the base frame of any dynamo will show when too great a preponderance of weight is delegated to that inanimate object.

Again the rating given a dynamo by the maker should not always be accepted. The various machines offered should be placed on the same basis for estimating their capacity, namely: assuming the highest point of efficiency at full load, the added capacity of the machine beyond that should be regarded as an overload. Most dynamos are rated at their utmost capacity, irrespective of efficiency or temperature.

A 150 K. W. alternating dynamo rated at 130 amperes and 1,150 volts is worth but 86 per cent. of one of equal quality rated at 150 amperes and 1,000 volts, the first being the output at the dynamo, the latter the output at the centre of distribution where it belongs. This difference in actual value is reduced to 75 per cent. if the first dynamo is rated at full capacity, and the latter at its most efficient output.

It may be a question of the value of money to you whether you can afford to buy slow speed machines at their increased cost. The Harrison Street station of the Chicago Edison Company has shown an extraordinary reduction in cost of current per kilowatt hour by the use of direct connected machinery; but the units are from 500 to 1,500 kilowatts. A fair estimate of the added saving in the use of direct connected apparatus would be in a

100	K. W.	machine	10	per cent.
200	"	"	20	"
300	"	"	30	"
500	"	"	40	"
1,000	"	"	50	"

In buying arc apparatus the speed and weight should also govern in nearly the same degree the price of the largest size you can use. The pressure which reaches 6,500 volts in a 125 light arc dynamo seems to be carried on the ordinary arc circuit as easily as 3,000 volts. Of course 6,000 volts will jump nearly twice as far and theoretically would require twice the insulation to hold; but experience has shown that if an overhead arc line is built to protect a pressure of 3,000 volts, it will carry 6,000 volts with safety. No reliance whatever is placed upon the insulation of the ordinary No. 6 overhead arc line, which should be erected as if the wire was bare; as almost all such lines five years after erection are bare, so far as insulating qualities are concerned. The weak spots requiring increased insulation are the wires from the pole to the lamp or entering stores. Beginning then at the pole these wires should be a high grade rubber insulation. The regular weather proof line wire will give constant trouble even when protected with porcelain or hard rubber bushings or flexible tubing. It is not necessary to use rubber insulation throughout your overhead arc line, even with 150-light arc machines.

When the purchaser comes to buy alternating apparatus he is confronted with single phase, quarter phase, two phase, three phase, multiphase and monocyclic, surely enough to phaze him to start with. (The author then gives a brief description of the various types of single phase, 2-phase, 3-phase and monocylic machines.)

You are all familiar with the difference of cost in erecting and maintaining two or more circuits instead of one or three wires instead of two; but some buyers neglect the consideration of this expense until their multiphase apparatus is purchased, when it confronts them with the nasty familiarity of the unexpected expenditure so usual in disbursing our wonderfully overestimated receipts.

Again at least one two-phase system advocates limiting the loss in line copper to 2 per cent., the alternative of having a greater line loss with a smaller expenditure of cash for copper, is, a reduction in the efficiency of the service and usually the use of condensers. It is Hobson's choice as to the amount of money required, though you might get time on apparatus, while copper is cash.

The phase affects the units in which your power is distributed. Impedance lag and idle currents develop as the size of the self-exciting motor increases, practically limiting the distribution of power on a single phase circuit to motors not exceeding in size 100 H. P.

The single phase generator may be a 1,000 horse power machine, but any one of the motors must not be larger than 100 horse power unless independently excited and started.

So far as the phases are concerned, the only conditions under which a multiphase system is more applicable than a single phase is in the transmission of very large amounts of power over great distances and where the power is distributed in several units. After the phases the important consideration is the number of alternations or the frequency.

Generally speaking the higher the frequency the better the lighting service. The frequency of 3600 alternations per minute or 30 cycles per second is suitable for power only and will not commercially operate an arc or incandescent service at all; because the low period current waves produce an undulating and decidedly fluctuating light. Power is practically limited between 20 and 150 cycles per second or 2400 and 18,000 alternations per minute, because lower frequencies reduce the speed and increase the weight of motors and transformers beyond a commercial economy, while higher frequencies mechanically prevent getting the necessary number of pole pieces within an efficient compass or radius.

Running any make of alternating arc lamp from the incandescent transformer has not yet produced a competitive arc service; and applying the known results to the plants represented in this Association, the application would resolve itself into the use of the regular arc dynamo and lamp where the number of lamps exceed forty. When an alternating station has an output of a few arc lamps by all means use the alternating arc with a special transformer permitting the use of the ordinary carbon, but when you can sell more than forty arc lamps, the saving of the current lost in conversion and the single wire circuit of the regular arc system must then commend itself.

The alternations also affect the ordinary transformer. But two makers to my knowledge build a transformer especially for 7,200 alternations. All the other manufacturers build a transformer designed for high frequencies; and without altering the patterns or construction beyond a few trivial changes to make room for the necessary added ampere turns of wire offer a transformer presumably suitable for any frequency.

How does this affect the man who buys transformers? If he has a high frequency current, this type of transformer will

consume 50 per cent. more magnetizing current than one designed only for high frequency. If he applies the high frequency transformer to the low frequency current the lack of necessary ampere turns of wire or weight in iron makes the loss in magnetizing current still greater and the transformer mighty hot.

The quick repair transformer wherein the iron field is split in two, so the coils can be readily replaced, is too dear at any price; the broken magnetic circuit causing too great a loss of current in energizing the transformer, apart from the charring of the insulation by the excessive heat generated.

It is an apt illustration of the eternal fitness of things that the electrical apparatus built to repair easily, soon develops a determined disposition to accommodate you.

Summing up the brief opinions offered might suggest to the members of this Association who are probable buyers of new apparatus:

1. If the amount and valuation of your money will permit, buy direct connected apparatus.

2. If your means or present arrangement of power suggests the purchase of belt driven dynamos, buy the heaviest slowest speed machine of the largest capacity practicable.

3. Use 2½-watt lamps; 2-watt if you can buy them.

4. If your power service is in small motors none of which are larger than 50 H. P. use single phase apparatus; if in motors larger than 50 H. P. use multiphase.

5. If the proportion of lights is greater than power, buy high frequency apparatus; if power is the most important service, buy low frequency.

6. Use the largest transformer practicable having the best regulation consistent with minimum loss on no load.

7. Sell all your current through meter, and check up the station output with your receipts.

These suggestions numerically arranged like the Commandments will not be taken, I trust, as advice. Advice is the cheapest thing I know of, and I value my opinions too highly to offer them to any but those who choose to entertain them.

THE UP-BUILDING OF THE SMALL TOWN.[1]

BY FRED DE LAND.

THOUGH we may not agree with the pessimistic side of the question Mr. Fletcher so ably presented in "The Doom of the Small Town," yet we must admit that he clearly pictured the silent tragedy that is being enacted in many towns and villages from whence the young, the hopeful, the more ambitious depart to seek more suitable abiding places, leaving the dullard, the ne'er-do-well, the rich-in-purse-but-poverty-struck-in-soul to rust on in unhelpful existence. And while citing many causes that may have led to present conditions his conclusion that: "Whatever be the causes, unless tendencies be arrested, the future of the small town is extremely discouraging, and it is very doubtful whether any material change in existing conditions will soon occur," is not nearly correct.

But the question I propounded to myself while reading this article was: Has Mr. Fletcher shown us only one side of the shield and that the dark side? Is it not possible to gather statistics relating to small towns that would have shown a condition of prosperity in many, even though such a showing would rob the first portion of his paper of much of its gloom? For there is nothing new in villages being deserted for towns more favorably located or offering greater advantages to the inhabitants. Such movements in our country can be traced as far back as A. D. 1700.

The reverse side of the shield shows that never before have so many small towns enjoyed modern improvements that not only tend to make life better worth the living, but also to increase property values out of all proportion to original investment. In the very States he mentions are towns of only six hundred, eight hundred and a thousand inhabitants with electrically lighted streets, with well kept roadways, and surrounded by that atmosphere of prosperity that attracts and invites the refined, the practical and the prosperous. In Michigan there are seventy-one incorporated cities varying in population from 287,837 (Detroit) to 746 (Gladwin) and in every city there is one or more electric lighting plants, which is not at all strange. But there are also 309 incorporated villages reporting a population in 1894 varying from 91 to 6,051. Of these 309 villages, nearly 100 have electrically lighted streets, though several reported a population considerably less than 1,000 souls. Compared with the census of 1890, the census of 1894 records a decrease in population in several towns and villages, but in no town of electrically lighted streets was any decrease reported, while the growth in some of these electrically lighted towns is almost marvellous.

Speaking to a Michigan merchant on this subject, he replied that in his town of nearly 3,500 inhabitants the marked growth in population and in prosperity had its inception in the order of the village board directing that electric lights be employed in illuminating the street at night. "Now the hanging of those big lamps in our streets has indirectly wrought as marvellous a change as often follows the placing of a new and attractive carpet in the reception-room of the old homestead. Gradually the old style furniture is replaced by the modern and more attractive until finally the room is modernized throughout, is artistic and comfortable. So it was in our town. The arc lights gave us a taste of progressiveness and awoke a desire for other improvements. Later the main streets were all paved with asphalt or with brick, and additional lamps were placed at street corners. Then some old frame stores that had been a fire menace for years were torn down and a modern office building erected on the site. These improvements furnished our local editor with a subject to talk about, and soon the fame of our house cleaning had penetrated every hamlet in the state. That this fame brought its own rewards is shown in the fact that we now have no less than seven factories, one of which employs 180 hands, and five large modern stores to say nothing of numerous small shops, two new school houses, three churches, while 583 new dwellings and other buildings have been erected since the arc lamps were placed in circuit, and when I consider how remarkable are the changes that have been wrought, and how we might still be jogging along in the old way had the dozen oil lamps not been displaced by the big white lights, I feel very grateful for the wisdom and the forethought that ordered the expenditure that proved to be so profitable an outlay."

This is a homely illustration but thoroughly sensible and practical, and one that many a village resident might profitably ponder.

The author gives additional instances of like nature and then continues:

Surely it is more pleasant to read instances of this character than it is the despondent conclusions Mr. Fletcher has presented in *The Forum*. And it requires no vivid stretch of the imagination to conclude that just as satisfactory experiences might have been recorded in some of the Massachusetts towns that report such a marked decrease in population during the past ten years. The State census report just issued shows a loss in the ten years intervening between 1885 and 1895 in 140 towns and villages. The streets of some of these villages and towns have never been lighted with electric lamps, and the decrease in population reported in each ranges from 5 per cent. to 25 per cent., while, on the contrary, many other villages have advanced rapidly in population. Millis, for instance from 683 to 1,006, or an increase of 47 per cent. from the day that modern progressive methods predominated. Millis, it is needless to state, is a town of electric lighted streets. Then there is Dudley with a gain of 17 per cent. in population, and a dozen other electric lighted villages all showing marked gains, while their neighbors puttering along with dark streets had slowly degenerated.

STORAGE BATTERIES IN CENTRAL STATIONS.[1]

BY MAURICE BARNETT.

THOSE who were present at the last convention of the Northwestern Electrical Association will recall the paper on "Storage Batteries in Railway Plants" read by Mr. G. Herbert Condict,—and will also recall that the paper in question did not excite any unusual discussion. At the Cleveland convention of the National Electric Light Association Mr. Nelson W. Perry reviewed the general aspects of the "Storage of Energy" and expressed what he considered to be the relative value of different forms of storage apparatus in a central station. So far as his remarks on the storage battery were concerned there was very little concurrence of opinion with him,—and the discussion that was started drew, from a number of practical electrical engineers, expressions that were favorable to the use of storage batteries in central stations. At the meeting of the American Institute of Electrical Engineers, held November 20th, 1895, not fewer than four able papers were read on the subject of storage batteries and the general consensus of opinion seemed to be that storage batteries, looked at either from the standpoint of first cost of general utility and economy in the station, were a decidedly valuable adjunct of central stations. Again, two years ago there was only one important storage battery plant in use in a central station in the United States, and station managers were not seriously considering the installation of this form of accessory apparatus. During the past two years very large battery plants have been placed in Boston, in New York, and in Lawrence, Massachusetts, by local Edison companies, while two battery installations have been made in Merrill, Wisconsin, and Anaconda, Montana, in connection with railway power plants. Since the first installation was completed at Lawrence, Massachusetts, the battery capacity has been doubled, and it is understood that the advisability of increasing the capacity of some of the other stations in the same way is conceded. Negotiations for storage plants for other central stations have been carried on for some time and will probably end in our seeing the number of existing battery plants very greatly increased.

1. Abstract of a paper read before the Northwestern Electrical Association, Milwaukee, Wis., January 15-17, 1896.

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What, it may be asked, has occasioned the change of attitude of electrical engineers and station managers towards the storage battery? The answer to this is:

First:—Litigation no longer stands in the way of the use of any of the standard types of batteries.

Second:—The application of special types of batteries to special kinds of work has resulted in a vastly improved performance of battery plants in meeting the exigencies of station work. This refers specially to performance of battery in acting as a reservoir for storing the energy represented by the difference between the average and the maximum load, as a regulator of pressure on circuits subject to varying demands and as a transformer utilizing high voltage charging currents and discharging at any lower voltage desired.

Third:—It is generally recognized that plants part steam power and part storage battery are cheaper than an all steam power plant would be for the same work.

Fourth:—The use of batteries in sub-stations frequently permits a saving in conductors between the central and the sub-station.

With regard to litigation it may be said that formerly when one bought a storage battery one contracted the liability to a law-suit at the same time. It is now generally known that this incubus on the storage battery business has been removed. One large company, ably managed, has obtained control of this business by securing to itself the right to manufacture in the United States, storage batteries of all the important types heretofore developed. It has also obtained control of valuable foreign patents as those covering the manufacture of the "chloride accumulator" and the "Tudor" battery.

The field has thus been cleared of litigation and those wishing to use storage batteries can do so without apprehending annoyance or loss in any way. This element of uncertainty was removed simultaneously with the dispelling of the prejudice against storage batteries, caused by their failure in certain applications for which, especially in their undeveloped form, they were notoriously unfit, a circumstance that has been of infinite value in removing the most important obstacle to the use of storage batteries in places where they were especially adapted.

Before taking up the practical side of this subject as covered by the adaptability, performance and economy of storage batteries in central stations it may be interesting to review a few typical battery plants here and abroad which have been installed to perform both regular and special functions. From the "Railway World" of November 12, 1895, the following paragraph is taken:

"The first accumulators used in connection with a railway power station were, so far as the writer can ascertain, those employed in the power plant of the railway lying between Zurich and Hirslanden, Switzerland, an account of which was published in the *Elektrotechnische Zeitschrift* of June 28, 1894. According to report the dynamo delivers current under a constant load, the accumulators being charged or discharged as load on the line is less or greater than the output of the dynamo. In this plant there were automatic means for cutting in and out of end cells to keep the voltage constant. Results showed that by means of the accumulators a saving was effected of 2.2 pounds of coal per hour, amounting to nearly a ton per day, or $2,500 a year. The cost of accumulators, installed complete with accessory apparatus, was $7,400. Allowing for interest and depreciation the battery paid for itself in four years by saving in coal bills alone. The saving was effected by reason of there being no necessity for keeping a second boiler and steam engine in reserve, —and that by this arrangement the power plant ran at its highest efficiency. It was furthermore developed that the first cost of combined steam power and battery plant was less than cost of total steam power plant would have been for the same work.

Two interesting battery applications were recently made abroad in the power plants of the "Douglas-Laxey line" and the "Snaefell Mountain Electric Tramway,"—both in the Isle of Man. In the Douglas-Laxey line it requires a current of 150 amperes at 500 volts to carry a car up the 8½ per cent. grade at a nine-mile rate. Before the battery was connected to the line the cars ran with exceptional smoothness,—the accumulators keeping the voltage steady and eliminating the variations due to sudden starting of cars.

The Mt. Snaefell battery plant consisted of 246 special cells of the chloride accumulator type. At 550 volts, the battery furnished 176 amperes for hours; 112 amperes for 6 hours; 84 amperes for 9 hours; and 72 amperes for 12 hours. The battery was used in precisely the same way as that on the Douglas-Laxey line with the exception that a special use was made of it at seasons of the year showing but little traffic. By agreement the line bound itself to run two cars a day each way every day of the year. As it would not pay to keep the power house in operation just for this load the practice was adopted of charging the battery once a week and allowing it to carry the whole load for the other six days.

Lastly there is the Germantown plant. This battery installation is used to carry the peak of the load and also the minimum load. Speaking of this latter function, Chas. M. Allen, the superintendent has put himself on record as follows:—"In the second place, we do not have sufficient day load to pay us—and it is here the battery comes to our relief. Before we used the battery, the loss on our day circuits was most discouraging. By the use of the battery we have wiped out this loss and can show some profit besides. We now shut down the machinery in the early morning and the battery carries the entire load until nearly dark; then after midnight, while the load is light, but while we must still run our city lights we charge the battery and it is a fact noticed by our engineer, as shown on his reports, that he uses about the same quantity of coal on nights he does not charge the battery as when he does."

We can now take up in a general way the questions of adaptability, performance and economy of the storage battery in a central station considering these in the following order:—

1. Ability of battery to carry peak of load. 2. Economy of battery to carry minimum load. 3. Ability of battery to regulate pressure. 4. Storage batteries in sub-stations.

It is a fact which managers of central stations will testify to that the maximum output of an electric lighting plant is limited to 1½ hours or at most to 4 hours a day. In designing a central station the engineer must choose between several alternatives. First, if he puts in complete steam power plant of most modern type to handle the maximum load, over half of the plant will be idle the greater part of the day, from which it will follow that the profits of lighting will be greatly reduced by large interest charges and heavy stand-over losses in the boilers. Such a plant, besides being very expensive, has no reserve capacity in case of accident. To off-set the question of large first cost it has been proposed to introduce the best type of economical machinery to handle the average output with some less expensive apparatus to take care of the overload. For the latter work, Mr. Perry has proposed gas engines to drive extra dynamos. Such a plant while avoiding the stand-over losses to which a boiler plant is subject, and showing smaller interest charges, is open to the objection that amortization expenses of cheap machinery, not to speak of loss in efficiency, counter-balance the saving in interest. Nor has such a plant any reserve capacity in case of accident. Mr. Perry's suggestion of gas engines would be valuable were it not for the fact that every failure to ignite would appreciably alter the speed of the dynamos, as gas engines cannot maintain their speed when obliged to make two revolutions on a single explosion. As a matter of fact in gas engine plants a storage battery is considered almost absolutely essential as a regulator and as a reserve against break down. Lastly, there is the combination of a steam power plant to handle the average output and a storage battery to take care of the overload. Storage batteries of central station type can be installed for this work for about one-half what a steam power plant would cost,—making a plant half steam power and half storage battery cost only three-quarters what an all steam power plant would for the same work. Mr. C. L. Edgar, general manager of the Boston Edison Illuminating Company, which is the owner of the largest storage battery plant in the world, has put himself on record as to the accuracy of the above figures.

A question that arises here is as to the maintenance cost of such a battery. Generally speaking, it should not exceed that of direct generating machinery. In work of this kind, therefore, the storage battery has undoubted economic value as it suggests the way of designing a central station that will be only moderately expensive and which will be safe-guarded against stoppage arising from accident to the generating machinery.

Coming now to the question of the economy of using storage batteries to carry the minimum load it may be said that opinion is divided on this point. Abroad where the motor load is insignificant the minimum demand for power lasts for half a day. It is thus possible to get along with a single shift of men and something is also saved by drawing the fires, banking the boilers, or other practice when it is not intended to run plant, and it is considered more economical to let the battery take care of the minimum demand than to handle it with the direct minimum machinery. In this country the motor load is very important and the minimum load lasts only from 4 to 6 hours a day. A whole shift of men cannot thus be saved. Experiments have been tried in Boston on a large scale with a view to ascertaining the value of a storage battery in this connection. As yet no definite conclusions have been reached on this point. Undoubtedly there are numerous cases where the minimum load is small and lasts for half a day at least—making it economical to use a battery. The Germantown plant is a case in point where most satisfactory results are obtained by using a battery in such a connection.

One of the most important and valuable functions of a storage battery in a central station is as a regulator of pressure. To anyone who watches the variations in the voltage and amperage of generators running with and without storage batteries, conviction will soon come that the voltage varies perceptibly less when a battery is arranged in parallel with the generator than when it is not. When a shunt wound dynamo, such as are used in central stations, is running alone, any increase in ampere output will be attended by a fall in voltage. When on the other hand a battery is combined with the dynamo, the moment the pressure falls from a large demand for current on the line, the battery begins to discharge and thus augments the output of the dynamo. In other words the battery acts as a reservoir; when the load on

the line is small the battery is charged; when the load becomes heavy the battery begins to discharge and in so doing performs a doubly valuable function. In the first place it saves the generating machinery from strain, and, secondly, by keeping the pressure constant, makes possible a much higher efficiency both in the station and on the line. Mr. Edgar has said that if a steam plant and a battery plant were on a par in all other respects he would personally feel very much inclined to install a battery plant for the above reason alone.

Lastly we came to the question of the use of storage batteries in sub-stations. Just imagine a city which has spread out irregularly At some distance from the central station it may happen that the population is large and that considerable current will be required to furnish adequate light. If the situation is such that it is cheaper to furnish light from the central station than to operate a small power plant as a sub-station the former will be done. The consequence of this will be shown in very heavy losses in the line owing to large currents transmitted, and secondly there will be very heavy interest charges for very large conductors. If on the other hand a storage battery sub-station were located in the centre of this suburb the following economies would be gained. In the first place much smaller conductors would be employed, resulting in diminished interest charges, and secondly a high tension current would be used in transmission by which losses on the line would be lessened. These economies are brought about by the ability of the battery to act as a "transformer." In other words the battery may be charged in series with a high tension current and discharged in multiple bringing the pressure at the sub-station down to requirements.

On the other hand a battery may be charged in multiple and discharged in series by which it will be possible to get along with one dynamo instead of two or more in series. Owing to the flexibility of storage batteries they are splendidly adapted to working on a three-wire or a five-wire system.

There is one point that has not, thus far, been touched upon, namely, the coal consumption in a station consisting of both generators and batteries. The use of storage batteries is sometimes objected to on the ground that there is a loss of fifteen to twenty per cent. of the watts generated while the battery is being charged. Perhaps we can do no better than by quoting Mr. Edgar again. "The watts lost," says Mr. Edgar, "by the inefficiency of the battery are made up more than four-fold by the better economy of the steam plant. We have taken typical winter days and figured out exactly the cost of running our system with the battery and without, and have proved that the actual coal consumed with the battery is a material amount less than without it."

To recapitulate, storage batteries are valuable in central stations on account of the three-fold function they perform, as reservoirs of energy, regulators of pressure and transformers of high to low or low to high tension currents. In performing these functions they make possible lower first cost in main central station and lower first cost for conductors between this and the sub-stations where batteries may be installed. They are, further, valuable in saving the power and generating machinery from strain and in effecting economy by introducing the factor of high efficiency in the station and on the line.

LEGAL NOTES.

DATA ON STREET RAILWAY CONSTRUCTION IN NEW YORK.

THE action brought by the Southern Boulevard Railroad against the People's Traction Company and the North New York City Traction Company, and Comptroller Fitch to restrain the latter from awarding to the first defendants a franchise for surface roads between the Harlem and the Bronx Rivers, it being alleged that the bidding for the franchise, which ran up to nearly 7,000 per cent. of the gross receipts, was farcical, was put on trial last week in Part III. of the Special Term of the Supreme Court. It will be remembered that the bidding was suspended by a preliminary injunction which Justice Beach continued until trial.

Its chief interest lay in the important evidence of H. H. Vreeland, President of the Metropolitan Railway Company, who was called as an expert, and gave statistical evidence concerning the cost of construction, of equipment and of operation for surface roads operated by electricity.

He said that the cost of construction per mile varies from $10,000 to $35,000 according to local conditions, and the requirements of municipal authorities. For example the paving required here by the city costs $6,000 a mile. The average cost of a trolley car including motors up to the moving of the car is $2,000. The average cost per car-mile of operating an overhead trolley system is 14 cents in New York, 18 in Massachusetts, and 15 in New Jersey.

The per cent. of operating expense to receipts varies from 55 to 60. The per cent. depends on the density of population and whether the riders are through passengers or short-trippers. The witness said he was not familiar enough with local conditions in the towns of Mamaroneck, New Rochelle, Rye and Pelham to give an estimate of the rates of operating expenses to receipts.

The Lenox Avenue line in this city, was originally built for a cable and then changed into an underground trolley road by the General Electric Co. The One Hundred and Sixteenth Street cross-town line, built originally for an underground trolley, cost $45,000 per mile of single track, which included considerable paving. In a suburban section where paving need not be considered a similar track could be laid for $30,000 a mile. A cable road would cost three times as much, but the legitimate place for a cable line is a straight track. The cost of constructing a storage-battery line would be the same as for a trolley less the cost of overhead construction. To operate by storage battery on a horse-car track would cost a third more because of the extra weight of the cars and their rocking. To build a horse-car track costs $20,000 a mile. An overhead trolley costs 60 per cent. of gross receipts, compared with 75 per cent. by horse power. The cost of equipping a road twenty miles long in the Twenty-third and Twenty-fourth Wards would be $2,000 a car, and a power-house would cost according to the number of cars to be operated—$2,000 a car. To operate forty cars would require a power-house costing $80,000.

WESTERN ELECTRIC CO. vs. NAT. TELEPHONE MFG. CO.—RULING ON DEMURRERS.

In the United States circuit court, Boston, on Jan. 13, Judge Colt heard arguments of counsel on the demurrer filed by the defendants in the case of the Western Electric Company against the National Telephone Manufacturing Company et al.

The suit is a bill in equity brought to restrain the defendant telephone manufacturing company and its officers from making, selling or using certain call boxes or telephone exchange apparatus for which the plaintiff claims to own patents.

The demurrer of the defendant company was on the claim that the plaintiff was not entitled to maintain its bill because it was not brought in the proper circuit as against it. The demurrer of the officers of the defendant company urged this claim as a ground for the action, together with the further claim that the plaintiff's bill alleges no joint infringement between defendant corporation and them, and also the claim that the bill stated no ground for equitable relief.

The court sustained the demurrer filed by the defendant corporation, and overruled the demurrer filed by the officers.

F. P. Fish and Barton & Brown for complainant; E. P. Payson for defendant.

HOW CITIES CAN SAVE MONEY.

No intelligent business man doubts, probably, that the entire volume of our city's business, for instance, could be done much better than it now is for one-half of what it costs if it were done on the principles that govern in the carrying on of private business. The clerical work in the city hall and in the various departments would show just as great a disparity against the public if compared with similar work done for private parties, as is shown in the comparison already alluded to between the cost of the public's janitor service and what private parties pay for similar service. Parties could easily be found to enter into contract—and give bonds for faithful performance—to do all the municipal work of Detroit, the paving, sewering, lighting, water supply, etc., for half what the city pays to-day. And they could make a handsome profit out of the business even then.—*Detroit Free Press.*

BROOKLYN BRIDGE AS A "MUNICIPAL PLANT."

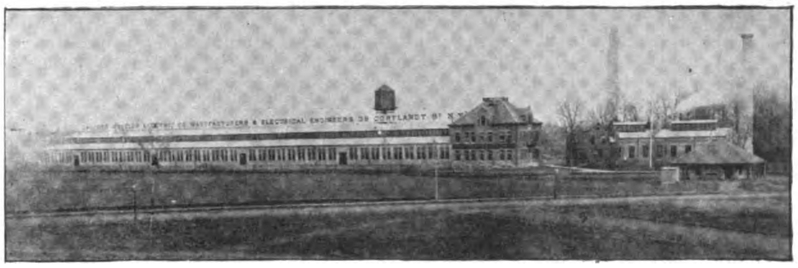
Legislative investigations have come, and legislative investigations have gone, and not one has yet touched upon the most magnificent piece of public mismanagement that the New York public was ever cursed with. I mean the great Brooklyn Bridge. It has often been said that the New York public is the most good. natured, long-suffering and patient of any city in the world. Visitors from other cities and foreign travellers marvel at this. It certainly must be true. If it were not so, I am perfectly sure that the stupid, ignorant, impracticable, thickheaded and incompetent management of the Brooklyn Bridge would have been kicked out of office long, long ago. If you have never attempted to cross the bridge during the so-called "rush hours," you would never believe that such a shocking condition of affairs could possibly be permitted in a civilized community. I can only think of one scene which parallels this—a panic-stricken crowd which pushes madly out of a theatre when somebody has started the cry of fire. I wish the readers of *The World* who read this paragraph would come down to the New York entrance of the bridge any afternoon between 6 and 7 o'clock, and then and there determine in the heat of righteous indignation what ought to be done to make this magnificent highway between New York and Brooklyn what it ought to be, and in the hands of intelligent men soon would be.—*New York World.*

Society and Club Notes.

VISIT OF THE AM. SOC. OF CIVIL ENGINEERS TO THE NEW CROCKER-WHEELER FACTORY.

In connection with the annual meeting in New York City of the American Society of Civil Engineers, a very interesting special trip was made on the morning of Jan. 15 to the rebuilt factory of the Crocker-Wheeler Electric Co. at Ampere, N. J. A special train of three cars was run from New York for the purpose, and it was crowded with members and their friends, about 50 ladies being also in the party. The honors of the occasion were done by Dr. S. S. Wheeler, president, and Prof. F. B. Crocker, assisted by several members of their engineering, office and factory staff; and a most instructive morning was spent.

The entire plant is new, having been rebuilt this summer on



General View of Crocker-Wheeler Electric Co.'s Shops, Ampere, N. J.

the site of the old works occupied by this company, which were formerly the works of the Spiral Weld Tube Company. The new buildings are of the modern slow-burning mill construction, and have been erected practically in accordance with the plans of the New England Mutual Insurance Companies.

The principal engineering feature is the electrical power transmission system which is employed throughout. All of the machinery is operated by individual motors built into each machine, or by separate motors, each driving a single length of shafting, which in turn drives as many of the old-style machines as can be conveniently belted to it. The result is, first, that all power used in connection with these machines is stopped whenever the machine is out of use, and second, that the works are free from belting, leaving them remarkably light and clear for handling material. In addition to the remarkable reduction in power required for operating the plant, this method of driving gives a shop system of great flexibility. This was well illustrated during the past summer when many of the company's machines were operated in their original positions in the ruins of the old works which were burned, under temporary covers, by means of temporary wires run to the motors built in them. The machines were afterward from time to time moved from one position to another as the work on the new buildings required, being kept, however, in continuous operation day and night. By this means the company turned out 20 per cent. more product this year than ever before in its history, in spite of the fact that for three months the entire plant was in ruins. A curious spectacular illustration of the flexibility of electric power was given by hoisting into the air by the electric crane a large electric lathe, which went on with its work, the long spiral of cutting from which curled off slowly to the floor all the time.

The lighting and power for the plant are supplied by a 150 horse-power Corliss engine driving an 80 kilowatt dynamo in the detached power-house. There is also an auxiliary plant. The current is conducted from the power-house by cables through an underground tunnel, which also carries the heating pipe and the cables for experimental work through the cellar of the office building, thence rising from a manhole under the floor of the main shop and running along under the roof by ordinary trolley line insulators to about the centre of the shop, where they terminate on suitable slate panels. From these branch out four sets of wires carried in a similar manner along the roof trusses and extending through and feeding the four quarters of the main building. By this arrangement the supply of power for either section of the shop can be readily discontinued by a small switch.

From the switchboard run also the circuits for supplying the other buildings. The branch connections from the main circuits are carried down the inside of the cast-iron columns of the building to a point about 6 inches below the surface of the floor; thence they are carried along through small wooden troughs, which were laid for this purpose in the concrete, straight across the shop close to the bases of each pair of columns, or 10 feet apart. The wires are brought up from the troughs through the floor wherever connections are desired, through 1-inch holes bored through the flooring. The wires pass into and out of the centres of the columns through small handholes cast in them near the top and bottom.

The king posts of the roof trusses are extended upward so as to furnish posts for the roof sign. The main building is 100 feet wide and 450 feet long, the office building adding another 50 feet to the length.

In the construction of the buildings it was decided to use a floor heavy enough for the foundations of any machinery it was desired to put down at any part, and which would also permit the carrying of heavy loads on roller trucks, rather than to introduce handcar or industrial railroad tracks, since this would greatly cut up the floor, and could not be arranged to reach every part and avoid interference of two cars on one track.

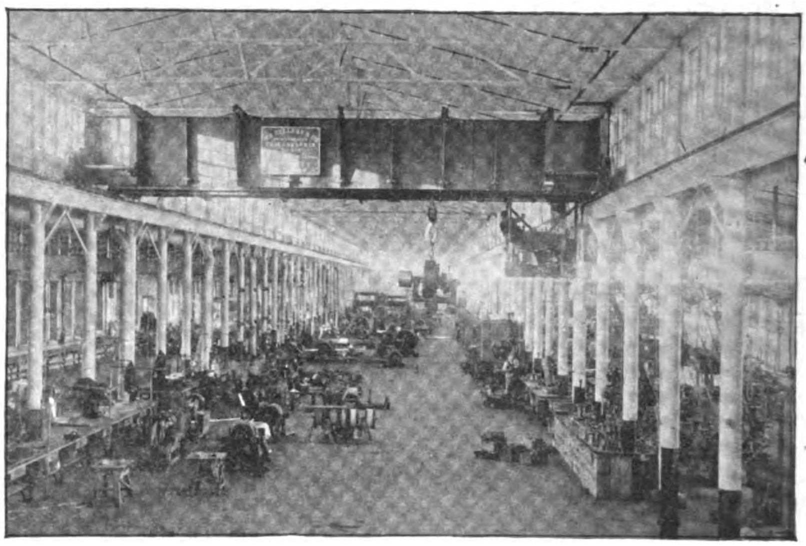
The beautiful office building is designed with special reference to facilitating the work of the engineering department and the management of the company. The general offices and the office of the chief engineer and assistants are on the main floor, with connections directly to the floor of the shop. The workmen's entrance, also on this floor, is so arranged as to make the men pass through the bookkeepers' department. The second floor contains the drafting department, blue-print and photographers' rooms, and the toilet and locker rooms. The third floor will be for assistants and storage. One half of the basement is arranged for a laboratory for such experimental work as it is desired to carry on without disturbing the shop; the other half is for bicycles. Up through all of the floors extends a fireproof vault about 10 feet square, with arched brick floors and air spaces on all sides, for the reception of the records of each department.

The visit closed with a very creditable fire drill, using water from the tank supplied from the company's electrically driven artesian well.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The 102d meeting of the Institute will be held at 12 West 31st Street, on Wednesday, January 22d, at 8 o'clock P. M. Mr. Frank J. Sprague will present a paper on "Electric Elevators, Their Uses and Advantages," embodying specific descriptions of various types which will be shown by lantern slides.

The meeting of the western members will be held on Wednesday evening, January 29th (one week later), at the Armour Institute, 33d St. and Armour Ave., Chicago.



Crocker-Wheeler Main Shop, Looking North.

ELECTRICAL SECTION OF THE AMERICAN INSTITUTE.

The above section held a regular meeting at the Institute headquarters on Jan. 17, when a paper on the subject of "Transformers" was read by Dr. M. I. Pupin, of Columbia College. The lecture was extremely interesting and was illustrated by many

brilliant experiments, dealing with lines of investigation on this important subject.

FOURTH ANNUAL CONVENTION NORTHWESTERN ASSOCIATION.

THE Fourth Annual Convention of the Northwestern Electrical Association began at the Hotel Pfister, Milwaukee, on Wednesday, January 15th, and was continued for the two following days.

The convention was opened in the forenoon by PRESIDENT GEORGE GRIMM. After making some feeling remarks as to the loss which the Association had sustained by the death of their late President, Mr. Henry C. Thom, whom he had succeeded, he entered into the business of the day. He said that he regretted to have to state that the Association was not in as strong a position financially, as was desirable. The president further added in this respect, that owing to the absence of the Secretary, Mr. Goltz, who is now in Europe, he had become very familiar with the business affairs of the Association. Without any extraordinary expenditures, he found that each succeeding report of the Secretary showed a deficit in the treasury. He believed that a plan could be easily devised which would again place the Association on a sound financial basis, and to help to attain this end he earnestly asked the members to be prompt in the payment of their dues.

Another matter which he said required the attention of the members was that the Association should distinctly define the extent to which the officers and the Association will go in furthering proper legislation relating to electrical matters.

THE SECRETARY'S report showed that the Association had grown considerably within the past year.

The election of officers for the ensuing year was taken up at the afternoon session, the following being elected: President, Pliny Norcross, Janesville, Wis.; first vice-president, Chas. D. Wyman, Milwaukee; second vice-president, H. C. Higgins, Marinette; secretary, Thos. P. Mercein, Milwaukee; treasurer, John Schuette, Manitowoc. Mr. Mercein takes the place of Mr. Wm. Goltz, who is now abroad.

Two papers were read during the afternoon. The first was by W. J. Buckley on "Modern Apparatus and Existing Conditions."[1] The paper by A. V. Abbott on "Economic Expression for Fuel Value," which was down on the programme, was not read, so Fred De Land followed with his very interesting paper on the "Upbuilding of a Small Town."[2]

In the evening a large number of the members and delegates visited the Bijou Theatre and witnessed the performance of the "Devil's Auction."

On the second day the session was taken up with the reading of papers, the most interesting being entitled "Some Facts About Acetylene Gas," by J. C. McMynn, and also a paper by E. R. Cunningham entitled, "Power Transmission Plants."

During the day a telegram was received from Mr. Pliny Norcross, who had been elected president of the Association, in which he declined to accept the office.

Owing to the absence of Mr. Norcross, Mr. C. D. Wyman, who was elected first vice-president, presided at the meeting.

In the evening the Association held its annual banquet, about one hundred people being present. After the dinner was over, a number of very lively and interesting speeches were made, amongst those who spoke being Thos. R. Mercein, H. G. Underwood, Geo. Cutter, R. C. Spencer, C. D. Wyman, F. DeLand, John Schuette, Jas. Wolff, E. H. Bottum, I. P. Lord.

The banquet was considered by all those who attended it to be one of the most successful that had been held.

At the third session the matter of electing a president to take the place of Mr. Pliny Norcross was taken up and Mr. W. B. Baker, Waupaca, Wis., was chosen. After some unfinished matters had been disposed of, the convention terminated.

The trip which it was intended should be made to view the fine new City Hall and also the Cudahy Packing Company's plant was abandoned, and a few of those who had attended made a visit to the engine works of Messrs. Allis & Co.

EXHIBITS AND CONVENTION NOTES.

THE CENTRAL ELECTRIC CO., Chicago, had their interests looked after by their representative, Mr. H. M. Latimer.

THE BRYANT ELECTRIC CO. of Bridgeport, Conn., were represented by Mr. Thos. G. Grier, of Grier Bros., Western Managers for the above Company.

THE AMERICAN CIRCULAR LOOM CO. were represented by their able Western agents Messrs. H. H. Brooks and A. D. Chandler, who kept well in line and with their usual energy boomed the conduit.

THE ELECTRIC APPLIANCE CO. had their energetic representative, Mr. W. W. Low, on hand. He is always to the fore at conventions, but unfortunately owing to pressure of business and other matters he had to tear himself away before the finish, which was consequently very tame.

1. See page 90. 2. See page 101.

MR. G. W. STURGES was on hand for the Joliet Steel Co.

THE HARTLEY ELECTRICAL WORKS of Chicago were represented by Mr. B. Hartley.

THE CUTLER-HAMMER MFG. CO. had a good representative present in Mr. H. H. Cutler.

MR. GEORGE CUTTER stood for himself as usual and represented his constituency very ably.

MR. C. W. WOODWARD was in the field for the Electric Storage Battery Co. for whom he is the Western manager.

THE COLUMBIA LAMP CO. were represented by their Chicago agent, Mr. J. M. Hill.

MR. E. DICKIE was around for the American Carbon Co., Nobleville, Ind.

MR. L. W. COLLINS, a well known Convention figure, was all alive for business for the electrical specialties carried by Lee & Collins, Chicago.

MR. ALBERT SMITH, of Keelyn and Smith, Milwaukee, was a frequent visitor to the Pfister during the Convention.

THE WESTERN ELECTRIC CO., Chicago, had their business well attended to by their representative, Mr. John W. Ebert.

CHICAGO GENERAL FIXTURE CO. were represented by Mr. C. O. Baker.

WESTINGHOUSE, CHURCH, KERR AND CO. sent Mr. Jerome B. Wilkinson, of their Chicago office, to represent them.

MR. THOS. RACINE, Milwaukee Auxiliary Fire Alarm Co., was to the fore at the Convention all the week.

JULIUS ANDRAE & SONS of Milwaukee were ably represented by Mr. Herman Andrae.

THE WISCONSIN ELEC. CONS. CO. were represented by Mr. F. Morawetz.

WILSON, CLARK CO. of Chicago were represented by their president Mr. J. McNeill Wilson and J. H. Clark, Jr.

LANGSTADT & CROSSWELL, of Appleton, Wis., were represented by Mr. M. H. Crosswell.

WARREN WEBSTER & CO. were represented by Mr. W. D. Pickels.

THE WESTINGHOUSE GLASS FACTORY was represented by its Chicago Agent, Mr. J. H. Reid.

THE ELECTRICAL PRESS was represented by F. L. Perry, W. P. Sullivan, A. V. Abbott, F. De Land, W. A. Remington, J. V. S. Church, L. L. Summers.

MR. J. M. ATKINSON, Chicago, representative of the Forest City Electric Co., Cleveland, was around, bright and energetic as usual.

MR. E. L. CLARK, of the Valentine Clark Co., Chicago, materialized from the bleak Northwest on the second afternoon of the Convention.

MR. JOHN T. MCROY, Chicago, showed his new underground shale conduit, his sample being a 4 duct of 3¼ inches diam. He explained to numerous callers the virtues of this recent invention.

THE SUNBEAM INCANDESCENT LAMP CO., Chicago, had the Messrs. F. S. Terry and A. S. Terry around with their habitual alertness, extolling the longevity and brilliancy of the Sunbeams.

THE ROYAL ELECTRIC CO., Peoria, Ill., showed one of their new transformers with removable coils for which they claim many sterling qualities. Mr. G. G. Luthy was constantly on the scene in their behalf.

THE ADAMS-BAGNALL ELECTRIC CO., Cleveland, were represented by Mr. L. H. Rogers, who found the days and nights altogether too short to allow him to tell everybody who wanted to know, all about the merits of their new lamps and specialties.

THE FORT WAYNE ELECTRIC CORPORATION provided a very substantial lunch to which all visitors were heartily welcomed. W. J. Buckley, C. E. Wilson and J. C. Murphy of the Chicago office looked after the wants of their friends in a very able manner.

THE WIRE TRADE was largely represented, Grimshaw and Raven Core, Safety, Simplex, American Electrical Works, Roeblings, Crefeld, Washburn & Moen, being all on hand with their energetic representatives, Messrs. Wolff, Austin, Hixon, Donahoe, Gordon, Lasell and Gill who were all activity for their various interests.

THE OSBURN ELECTRIC CO., Chicago, had on view their new conduit suitable for buildings; this conduit is made of galvanized steel tubing with 6-inch lengths of porcelain inside, for which they claim that it is absolutely insulating and fire proof. They also had a line of the Oscarow imported woven wire brushes. Mr. Roy Osburn and his assistant Mr. Wm. Gallagher were in charge.

THE PEOPLES ELECTRIC CO. of Madison, Wis., were represented by their Pres. Mr. L. W. Burch, who showed a very neat line of the electric light, street railway, and household supplies carried by this new and enterprising concern. They also had on exhibition a Paiste arc lamp focusser, Adams-Bagnall arc lamps, Standard telephones, and a very interesting lot of photographs of the electrical machinery manufactured by the Northern Electrical Mfg. Co., for whom they also are selling agents.

THE GENERAL ELECTRIC CO. had on exhibition two of the T.-H. 93 arc lamps suitable for direct or alternating incandescent circuits. They also had on show some switches and other electrical specialties, and distributed their Moonlight Schedule Calendars for 1896 to their visitors. Messrs. F. N. Boyer, A. C. Bunce, M. C. Wheaton, and W. S. Howell were on hand to greet friends.

The subjoined list includes the names not given in the Exhibit Notes:—A. V. Abbott, J. Angel, B. J. Arnold, A. O. Baker, R. M. Bashford, J. I. Beggs, H. F. Boggis, F. V. Boyer, R. E. Brown, A. C. Bunce, Carroll Collins, G. L. Cole, S. G. Coleman, G. M. Conway, Wallace P. Cooke, F. A. Copeland, Chas. Cuno, E. L. Debell, G. A. Farwell, W. W. Fisher, T. J. Fleming, Geo. Grimm, T. F. Grover, J. H. Harding, A. W. Hawley, H. C. Higgins, M. H. Hussey, J. H. Jones, P. H. Kolst, Edw. Lasell, Luke Lilly, I. P. Lord, G. S. McLaren, J. D. McLeod, E. G. Mullen, Geo. M. Newton, C. C. Paige, T. A. Pamperin, Frank A. Pigeon, O. M. Rau, Carl Richer, D. E. Roberts, C. H. Ruggles, John Schuette, Geo. A. Searing, A. Smith, W. C. Smith, J. S. Stephen, W. H. Thorp, F. Werner, J. F. Willey, O. B. Williams, C. D. Wyman.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS ISSUED JAN. 14, 1896.

Alarms and Signals:—

Messenger Call System for Buildings, H. Denver, Springfield, Mass., 552,897. Filed June 24, 1893.

Consists in the arrangement, with the call box conveniently located for two or more occupants, of one or more indicators which may be set to indicate or point out the room from which the messenger call was sent out.

Electric Bell, O. B. Sterling, New York, 552,983. Filed Sept. 3, 1895.

Conductors, Conduits and Insulators:—

Clip for Supporting Electric Cables, R. H. Lewis, Providence, R. I., 553,194. Filed Oct. 30, 1895.

Dynamos and Motors:—

Electric Motor, D. C. Jackson and C. M. Conradson, Madison, Wis., 552,961. Filed July 26, 1895.

Various novel features of construction.

Electric Furnace and Products:—

Manufacture of Carbide of Calcium, W. C. Clarke, New York, 552,890. Filed Aug. 24, 1895.

Consists in building up the furnace wall as the formation of the carbide progresses, adding fresh charges of the material to be treated as the wall is built up and keeping the lower end of the upper electrode at all times near the upper edge of the furnace wall.

Electrolytic Processes:—

Process of and Apparatus for Making Carbonates of Soda, T. Craney, Bay City, Mich., 552,895. Filed May 15, 1894.

Object is to make mono- and bi-carbonate of soda on a commercial scale by the electrolysis of salt brine.

Process of and Apparatus for Manufacture of Sodium Bicarbonate, T. Craney, Bay City, Mich., 552,955. Filed May 11, 1894.

Details of apparatus relating to the commercial manufacture of bicarbonate of soda from salt brine.

Process for Producing Cuprous Oxides, C. Hoepfner, Giessen, Germany, 552,960. Filed Oct. 7, 1893.

Consists in leaching cupriferous materials with a cupric chloride solution containing a solvent of cuprous chloride whereby a solution containing cuprous chloride is obtained, reconverting the cuprous chloride, and converting the cuprous chloride in the other portion of the solution into cuprous oxide by means of a suitable reagent.

Lamps and Appurtenances:—

Electric Arc Lamp, L. G. Nilson, Sioux City, Iowa, 552,967. Filed July 25, 1893.

Details of construction.

Electric Arc Lamp, F. J. Borland, Leeds, Eng., 552,982. Filed Aug. 17, 1894.

Specially adapted for projecting purposes.

Electric Lamp Support, J. Buckner, Boston, Mass., 553,220. Filed June 10, 1895.

Has for its object to provide an improved construction whereby the lamp may be insulated from the metal post. Also to protect the lamp trimmer from injury.

Miscellaneous:—

Electric Releasing Device, S. H. Reynolds, San Jose, Cal., 552,924. Filed Mch. 13, 1895.

Improvements in that class of devices which are adapted for use in stables, engine houses and the like, for releasing horses in case of fire.

Automatic Lighting or Extinguishing Apparatus, S. C. Stickle, New York, N. Y., 553,198. Filed May 10, 1895.

The circuit is closed by a clock at the proper intervals.

Automatic Electric Releasing Device, J. W. Chute, San Jose, Cal., 552,954. Filed Apl. 16, 1895.

An automatically operating release and resetting device which is applicable to open gates or doors, to release any mechanism, to disengage horses from their fastenings, etc.

Railways and Appliances:—

Motor-Truck, L. Warfield, Detroit, Mich., 552,922. Filed Nov. 18, 1891.

Secures the gear on the axle, so that while turning with it it is free to move longitudinally along it.

Street Indicator, C. Eby, Rocky River, Ohio, 553,058. Filed Aug. 28, 1895.

A belt which carries the names of the street, is operated by power transmitted from the trolley wire.

Trolley Cut-Out, T. Fletcher, Idlewild, Tex., 553,061. Filed Mch. 28, 1895.

A hanger made in sections coupled together and adapted to automatically uncouple as soon as the live wires break between adjacent hangers.

Bonding Device for Electric Railways, W. Brown, Camden, N. J., 553,099. Filed May 25, 1895.

The bond is expanded into the rail by a taper screw.

Electric Railway, T. F. O'Connor, New York, 553,176. Filed Apl. 2, 1894.

The motors are fed by separate conductors, each conductor having one end connected to and moving with the vehicle fed by it and the other end connected with the source of power and stationary as respects the movement of the vehicle, the length of the conductor being sufficient to permit the vehicle to move the desired distance from the stationary end of the conductor.

Switches, Cut-Outs, etc.:—

Electric Circuit Connector, T. F. Nevins, Brooklyn, N. Y., 553,014. Filed May 16, 1895.

Adapted for use with portable electric lamps, small sized motors, etc.

Telegraphs:—

Automatic Closing Telegraphic Key, J. A. Coleman, Perry Station, Canada 553,106. Filed Nov. 13, 1895.

An attachment whereby the telegraphic key will of itself immediately close the circuit after the operator has removed his fingers from the finger button.

Telephones:—

Telephonic Apparatus, C. J. Schwarze, Adrian, Mich., 552,972. Filed April 22, 1895.

A combined magneto calling generator and transmitter.

Telephone Circuit, E. Slade, Newton, and J. S. Stone, Boston, Mass., 553,179. Filed July 12, 1895.

Device for preventing a "click" in the receiver in centralized battery systems.

MARRIED.

ANGIER-GILL.

At Harvard Congregational Church, Dorchester, Mass., on Thursday forenoon, January 16th, Mr. G. M. Angier, of Boston, was married to Miss Emma J. Gill, of Dorchester, and the happy couple immediately thereafter departed for a few weeks' honeymoon in the South. Mr. Angier has been well known in the electrical business for years, all over the United States, having travelled in every part of this country. For some years he made Chicago his headquarters, but of late he has been settled in Boston, representing the interests of the Mather Co. and later the Eddy Electric Mfg. Co. of Windsor. Mr. Angier is deservedly a popular man, and there are a very few who can count up so many warm friends as he has made in the past few years, by uniform courtesy, interesting personality, and by an ever-flowing fund of good humor and kindly good nature. All his friends will be glad to hear of his marriage and to wish him God-speed, and have evinced their warm regard by a large number of beautiful presents received at the house of the bride. The marriage was a very pretty and simple church wedding, the bride being accompanied by only one maid of honor, Miss Gertrude C. Bent, of Boston. Mr. and Mrs. Angier will be at home to their friends early in the spring, in their residence at Wahan, which Mr. Angier has recently built; and will reside temporarily at the Hollis in Newton, Mass.

REPORTS OF COMPANIES.

STANDARD ELECTRIC CLOSING UP.

The Standard Electric Company, whose factory is at 818 South Canal street, Chicago, and whose office is in the Home Insurance Building, that city, has made an assignment in the county court. The assignee is George M. Stone, of the law firm of Rich & Stone. A statement was filed as to the assets of the company, which are placed at $25,000, but the liabilities were not given. The company manufactures dynamos, electric lights and other electric supplies, and its president is A. G. Spalding. The other officers are E. E. Crepin, treasurer; D. P. Berry, manager, and George A. Mayo, superintendent.

Assignee Stone said the liabilities of the company are less than the assets, and all the creditors of the company will be paid in full. He said the company has not been making money of late, and the object of the assignment was to wind up the business, pay off the debts and close up.

THE JENNEY ELECTRIC MOTOR CO.

Mr. A. K. Hollowell has purchased a half-interest in the Jenney Electric Motor Company of Indianapolis and will at once take control of the financial and general business management of the company. Mr. Jenney will have charge of the manufacturing department. Mr. Hollowell has been the treasurer and financial

manager of Nordyke & Marmon for twenty years. For ten years he was interested in the electric department of the Jenney company's business. The Jenney company has recently moved into a new place, east of the city, at the Pan-Handle and Belt railroad crossing. Seventy-five men are employed, and room for more is already needed. The works are in operation day and night, and the company is running to its full capacity to fill current orders. An addition to the building is contemplated. The company manufactures motors and electrical apparatus, and has been making a specialty of elevator motors.

MAGUIRE & BAUCUS, LTD.

The company of Maguire & Baucus, Limited, has just been incorporated with a paid up capital of $250,000. The concern is formed largely for the purpose of export business in electrical apparatus, specialties, etc., and has connections throughout Europe and South America. Messrs. Maguire & Baucus in marketing Edison's latest invention, the Kinetoscope, all over the world, outside of the United States, have been very successful; and they are well known in electrical circles. The officers of the Company are Jos. D. Baucus, President; Frank Z. Maguire, Vice-President and General Manager; Walter B. Howe, Treasurer, and William M. Paxton, Jr., Secretary. The Company is located at 44 Pine Street, New York, and Dashwood House, No. 9 New Broad Street, London.

AM. RY. ELEC. LT. CO. ATTACHED.

Lawyer J. Campbell Thompson has obtained from Justice Pryor in the New York State Supreme Court an attachment against the American Railway Electric Light Company in an action brought by Alexander Tait on a claim for nearly $500 for unpaid notes of the company, and for rent of a machine shop in Brooklyn used by the company. A copy of the attachment was served on Assistant Manager M. T. Wilbur, of the Western Union Telegraph Company, who is trustee of the company's stock. Ex-Gov. Alonzo Cornell was once president of the company, and is interested in it.

LETTERS TO THE EDITOR.

FROM A LEADING STATION BUILDER.

Please accept my congratulations on the very excellent article appearing in your issue of January 8, on the Edison Central Stations in New York City. I can appreciate the amount of labor that is expended in preparing an article of this kind, and I am sure that it is worthy of most cordial endorsements.

J. H. VAIL.

NEW YORK CITY, Jan. 16, 1896.

ELECTRIC PHOTOGRAPHY WITHOUT LIGHT.

Further dispatches from London of Jan. 18, in regard to Prof. Rontgen's photographic work say:—The marvels of Prof. Rontgen's new photography are even greater than those which I have described in recent despatches. All the Professor's experiments have been successfully repeated in London this week, and many of them were shown at the meeting of the Camera Club on Thursday. It proves that the strange medium which produces images of hidden objects on a photograph plate is not light at all. It is equally incorrect to describe it as electricity. It is some force or influence produced by Crookes' tube when excited in a peculiar manner, but it is not the visible light or glow which comes from the tube. That visible light has the same qualities as an ordinary light. The invisible new medium has not the same qualities. For instance, it will not penetrate clear glass. It will penetrate ground glass, though more feebly than wood and other organic matter. Aluminum is far more transparent than glass. Even copper is less opaque than glass.

Mr. Swinton, the well-known electrical engineer, showed a large collection of these strange photographs which had been taken to the Camera Club. He employed a half horse-power electric current, and passing it through an induction coil, loaded ten Leyden jars. The discharge from them was passed through a second induction coil by a secondary system by which Crookes' tube was excited. He said that he had only succeeded in this way, and had failed with Crookes' tubes excited by an ordinary induction coil.

He showed pictures of the skeleton of a living human hand, a purse containing coins in which only the coins and the metal clasp of the purse were reproduced, and other objects.

The method of procedure was simply to place the object to be photographed between Crookes' tube and the usual wooden case containing the sensitive plate in which the negative is placed when carried to and from the camera. The slide is not removed, and an exposure of from four to twenty minutes is required.

Another cable dispatch of Jan. 19 says:—Emperor William had Prof. Rontgen to rush from Wurzburg to Potsdam to give an illustrated lecture to the royal family on his alleged discovery of how to photograph the invisible, and bestowed on him the Order of the Crown, the same second-class decoration that poor Koch got; but already it is found that this discovery was not only made by a Prague professor in 1885, who got an admirable photograph of Mont Blanc at dark midnight by the use of cathodic rays, but that a full report of the achievement was made to the Austrian Academy of Sciences in 1885.

An item in the *New York Sun* recalls the fact that Mr. Edison some time ago produced a plate which would record in the dark the fact that it had been near a warm body. Mr. Tesla has also called attention to the actinic qualities of the electric rays with which he has produced photographs by "phosphorescence."

PERSONAL.

THE TENDER MERCIES OF THE CZAR.

A special dispatch from Pittsburgh of Jan. 10, says:—In May last Alex. Boroday, a Russian by birth, an electrician in the employ of the Westinghouse Electric Company, was sent to Russia in connection with the establishment of trolley railway plants in that country. He had been a political offender before coming to America six years ago, but the Czar's amnesty proclamation made him feel safe in going back. A letter from Kiev to another Russian resident here states that Boroday was arrested there, and that nothing can be learned of his whereabouts. It is supposed, the letter adds, that he has been exiled to Siberia. The officials of the Westinghouse Company have written to Secretary of State Olney, invoking the aid of the Government in behalf of the missing man, who is a naturalized citizen of the United States.

MR. GEORGE COCKINS, formerly of the Waterbury, Conn., Electric Light and Traction Co. as assistant manager has succeeded Mr. O. F. Strunz as general superintendent of the Bristol and Plainville Tramway Co.

ELECTRICITY AND VEGETATION.

Two important Papers, says *Nature*, have recently been published on the effect of the electric light and of electricity on vegetation. The first is by M. Bonnier in the *Revue Générale de Botanique*. He states that a continuous electric light promotes the formation of chlorophyll, and brings about, at the same time, a simpler anatomical structure of the leaves. Under a continuous electric light the distribution of the chlorophyll in the tissues is more extended than in ordinary daylight; chlorophyll grains make their appearance in the cortex as far as the endoderm, and even in the medullary rays and the pith. The palisade tissue of the leaf is reduced, or entirely disappears, and the epidermal cell walls are thinner. The bark is less developed, and the various tissues of the stem are less differentiated. When the electric light is discontinuous, as, for example, when turned on 12 hours out of the 24, the effect on vegetation is intermediate between that of normal sunlight and that of a continuous electric light. Alpine plants cultivated under a continuous electric light exhibit points of structure identical with those of Arctic plants, which are exposed to almost continuous sunlight in the summer. The other Paper is by Prof. A. Aloi in the *Bulletino* of the Italian Botanical Society. He adduces evidence in favor of his view that both terrestrial and atmospheric electricity exercise a favorable influence on the germination of seeds and on the growth of plants, and predicts that the employment of electricity will be a most important factor in the agriculture of the future.

THE VOLATILIZATION OF CARBON.

M. Moissan finds that when carbon is volatilized in his electric furnace it evaporates without melting, and that when the vapor condenses it always deposits as graphite. He also finds that aluminum carbide may be made, mixed with metallic aluminum, by the direct reduction of alumina with carbon in the electric furnace, and that when this carbide is treated with water it evolves chiefly marsh gas or methane (CH_4), not acetylene. This promises to furnish a new starting point for the methyl compounds and derivatives, which have hitherto been derived from the products of distillation of wood; and it casts some light upon the cause or origin of natural gas.

STEAM TRAINS DRIVEN OFF BY TROLLEY IN OHIO.

The Cleveland, Akron and Columbus Railroad Company has taken off its road four passenger trains on account of the electric line competition between Cleveland and Akron.

Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

A DEMONSTRATION OF THE AIR-BRAKE IN BROOKLYN.

The gripman of Car No. 1 on the Montague Street line of the Brooklyn Heights Railroad Company had a chance to test the reliability of the air-brake recently placed on the car by the Standard Air-Brake Company of New York. The car was speeding along Montague Street at a rapid rate, when at Clinton Street, two intoxicated men attempted to cross the track. Seeing the car approaching they stopped to let it pass, but all of a sudden they made a dash and crossed directly in front of the car. The gripman realizing the danger, applied his brake and brought the car to a stop a few feet from the men, who not realizing the danger crossed safely.

ELECTROLYTIC REFINING AT ANACONDA.

THE Anaconda smelting plants have a combined capacity for producing 5,000 tons of pig copper per month. The electrolytic refinery is now producing 1,500 tons of refined copper per month. This plant is now being doubled, and early this year the output will be fully 3,000 tons of electrolytic copper per month at its own works.

APPARATUS WANTED AT LUDLOW, KY.

Mr. J. J. Weaver, civil engineer and superintendent, Ludlow, Ky., writes us: "I shall be in the market about March 1 for station apparatus and line material for a power house at Ludlow Lagoon. The apparatus will be for both light and power purposes."

BALL ENGINE PLANTS.

The power for the electric plant in the Young Women's Christian Association Building at Chicago, will be furnished by Ball engines built by the Ball Engine Co., Erie, Pa.

The Troy Iron & Steel Co., Troy, N. Y., are putting in a large electric plant of their own, consisting of three 115 H. P. Ball tandem compound engines direct connected to Westinghouse dynamos, and one 165 H. P. Ball tandem compound engine belted to Westinghouse dynamo.

ADVERTISERS' HINTS.

THE EMERSON ELECTRIC MFG. CO., of St. Louis, claim simplicity, efficiency and durability for their alternating current power motor. They also state that it will start with fifty per cent. overload.

THE ELECTRIC APPLIANCE CO. are prepared to make prompt shipments from their Chicago stock of celebrated "OK" weatherproof wire.

MORE THAN A THOUSAND MOTORS in use on the street railway systems of Brooklyn are insulated with "Micanite," of which the Mica Insulator Co. are the sole manufacturers.

THE STANDARD AIR BRAKE CO. wish it understood that they are not asleep, but that they are prepared to equip any car or electric locomotive in existence with the "Standard" air-brake; and, further, they say that anybody reading their new catalogue will have no doubt of it.

THE CALCULAGRAPH is now on exhibition at the bicycle show in Madison Square Garden, where all who are interested may examine this valuable instrument "for keeping tab."

SWITCHBOARDS in all sizes and for every style of plant are built and installed by the General Electric Co.

ONE HOUR TO CHICAGO would be the time required travelling with the velocity of a rifle bullet. The Metropolitan Telegraph Co. remind the public that with the "Long Distance" you can be there instantly.

THE CREFELD ELECTRICAL WORKS continue to make and sell every variety of insulated wires.

THE ELECTRICAL ENGINEER like wine improves with age, and on this principle alone, it being the oldest electrical journal on the continent, is the best. It has other claims, too.

CARBONS THAT WILL BURN, and purchasable at a moderate price, are advertised by F. S. De Ronde, the American agent for the famous "Ship" brand.

A. O. SCHOONMAKER, 158 William St., is now prepared to furnish mica discs and washers stamped out of India or amber mica. If you want anything in mica write him for information.

THE PENNSY LIKES IT.

The Pennsylvania railroad, encouraged by success in the east is planning to equip the Springfield, Ohio, branch of the road with electricity. Expert Crawford, of Altoona, Pa., has been instructed to report on the cost.

NEW ENGLAND NOTES.

THE CROSHAW COMPANY has been organized at Kittery, Me., for the purpose of manufacturing, doing business in and leasing electric lights and electric apparatus, with $100,000 capital stock, of which nothing is paid in.

THE BERLIN IRON BRIDGE CO., of East Berlin, Conn., have just completed for the town of Houlton, Me., a new iron bridge 300 ft. long and 18 ft. wide, with a sidewalk 5 ft. wide. The Bridge Company furnished the entire bridge, sub structure and super-structure complete.

THE HOME ELECTRIC HEATING COMPANY has been organized at Portland, Me., for the purpose of manufacturing and dealing in all electric processes for heating and cooking, with $500,000 capital stock, of which $30 is paid in. The officers are: President, S. W. Clifford, of Boston, Mass.; treasurer, T. H. Pearse, of Boston, Mass.

THE BERLIN IRON BRIDGE CO., of East Berlin, Conn., have just completed for the Ansonia Brass & Copper Co., of Ansonia, Conn., a new boiler house 65 ft. wide and 142 ft. long. The side walls are of brick and the roof is entirely of steel, covered with the Berlin Iron Bridge Company's patent anti-condensation corrugated steel.

NEW YORK NOTES.

MR. A. D. DORMAN, so well and so long known in connection with Brush interests, has joined the forces of the Adams-Bagnall Electric Co., of Cleveland, and will hereafter have charge of their New York office, which has been opened in Room 1302 Havemeyer Building.

UTICA, N. Y.—The Utica Electrical Manufacturing and Supply Company has elected the following directors: W. E. Lewis, W. H. Cloher, Jr., W. C. Ballda, M. J. Brayton, Utica, and Frank S. Ferris, Prospect. The officers are: President, W. E. Lewis; vice-president, W. H. Cloher, Jr.; secretary and treasurer, M. Jesse Brayton.

PHILADELPHIA NOTES.

NEW WILMINGTON, PA.—Col. W. A. Clark and Prof. W. J. Shields, of Pittsburgh, are about to begin the manufacture of storage batteries at this place, the battery being an invention of Prof. Shields.

WESTERN NOTES.

WARREN, O.—The Warren Electric and Specialty Company has elected T. H. Gillmer president, C. H. Angstadt vice-president, E. W. Gillmer secretary and treasurer.

DETROIT, MICH.—The Michigan Electric Co. has put up a huge sign for a local store, which includes 400 incandescent grouped in letters six feet long.

DETROIT, MICH.—The city council of Lowell, Mich., has employed Humphrey & Carr, engineers of this city, to proceed with the erection of an electric light plant within the next thirty days. The plant will be run by water power located eight miles from the city.

ST. LOUIS, MO.—A 1,500 K. W. generator in the Union Depot railway power house short circuited recently and the whole road was stalled for about 40 minutes. The armature is said to have presented the appearance of a huge fire wheel while it spun around.

THE ELECTRIC APPLIANCE COMPANY report that their sales of the Packard transformers exceed even their greatest expectations, and they claim that after handling the same for three years, they have yet to receive the first one to be returned, burned out by lightning. They also claim that they carry a complete line at Chicago, and can ship any orders *promptly* from stock.

THE EMERSON ELECTRIC MFG. CO. of St. Louis are agreeably surprised to find such a strong inquiry for their latest achievement in the alternating current motor line—their single-phase power motor. Although this article has been for sale less than thirty days, it bids fair to become one of their leading articles of manufacture within a few months. They are proving to be all that are claimed for them and the "guarantee" of the Emerson Co. is ample assurance of a high class machine.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Financial, Miscellaneous, etc., will be found in the advertising pages.***

THE

Electrical Engineer.

Vol. XXI. JANUARY 29, 1896. No. 404.

Electric Lighting.

THE IDEAL ARTIFICIAL LIGHT.

BY

Elihu Thomson

READING over the article by Dr. W. H. Birchmore in The Electrical Engineer of Jan. 1, I note that the author has, in some of his work, simply formulated what has been the common experience, and what has been the growing experience of the past ten years or more, and, also, what has been known to every physicist, *i. e.*, that visibility depends upon the light which is being reflected having the same wave lengths as that which is used for illumination. Dr. Birchmore simply puts this matter on a scientific basis and emphasizes the conditions.

It has been commonly known that in a red light, containing low wave lengths, red colors are prominent while shades of blue become slatey and blackened, and tend to run into each other. With regard to the fact which he points out that the closing of the iris is due not simply to the rays proceeding from the object viewed but to the total rays which are transmitted whether they are used or not, I think it has been well known as a matter of common experience, though perhaps it has not been so definitely investigated as has been done by Dr. Birchmore. Every one knows that the presence of bright sunlight does not necessarily conduce to sharpness and clearness of vision, and that objects are even more readily distinguished in the shade, and this is more particularly the case when tints, or various depths of tints, are to be distinguished. Numerous instances of common experience might be mentioned in this connection illustrating these effects. The ordinary procedure of shading lamps which are to be used for reading, or shading the eyes when they are used in front of a light on a desk, are cases in point. It is true, also, that the color of the shade has an influence in making the light more pleasing or more effective for the purpose.

Along with other things Dr. Birchmore has pointed out, as a result of his observations, that violet light has vastly more power in its influence in closing the iris than has ordinary or yellow light. If these observations and the numerical relationship which he gives to the powers of these two lights in affecting the iris, are confirmed by further investigations, it will undoubtedly be of the greatest importance to make use of means for absorbing the higher rays of the spectrum or those which, without contributing much to actual illumination, still have the great power of affecting the iris which he mentions. If it be true, also, as I understand is claimed by Dr. Birchmore, that the incandescent light is rich in violet rays, or proportionately richer in violet rays than other forms of artificial illumination, then it would become a matter of great importance to apply the proper absorptive screens or media to get rid of such rays; and this conclusion would, of course, apply to every kind of light which might possess in too great a measure the power of closing the iris owing to the presence of the higher rays in undue proportion. I shall certainly look with interest to further developments in this particular portion of the field of research. It is difficult to see, however, why the incandescent lamp should have so large a proportion of the violet rays, as it is ordinarily run at a brilliancy which does not give even a true white light, but a light appearing yellow or orange as judged by ordinary unassisted vision.

I am glad to see that Dr. Birchmore endorses sunlight as the best illuminant. A believer in the doctrine of evolution must, of course, admit that the eyes of man have been developed more perfectly to use daylight than any other light. The old time ghastliness of arc lights seen at night, which ghastliness used to be talked about a great deal but which is seldom referred to now, I pointed out some years ago was due, in my opinion, to the accumulated experience of the race and the development thereof to expect that every light used at night should have a red or yellow tint. This education or inherited tendency has rapidly been evolved out of existence, and I may say that I regret even that the greenish ghastliness of the Welsbach burner does not seem to be one-tenth as offensive as it was on the first advent of the burner, which fact may, however, be due in a measure to a change in the composition of the network and not so much to education.

THE DETROIT MUNICIPAL PLANT FIGURES.

BY ALEXANDER DOW, ENGINEER PUBLIC LIGHTING COMMISSION.

THAT my "assumptions" as to municipal lighting costs should interest Mr. James I. Ayer, to the extent of calling from him a public criticism, indicates that further elucidation of these assumptions may interest the readers of The Electrical Engineer. Hence this communication.

Let me say first: I don't believe that municipal operation of street lighting is essentially superior to operation by a contractor either in cost or reliability; neither is it essentially inferior. Dynamos will run just as efficiently and reliably for a municipal corporation as for a lighting company, and men will work just as faithfully and just as hard for the one as for the other. If Mr. Ayer had built and operated his St. Louis street lighting plant for a municipality; if his control of operating force had been the same and the confidence given him by his employers the same, does he imagine that there would have been one iota of difference in the cost or certainty of operation because of the different ownership of the capital interested? Or does anyone who has met Mr. Ayer think he would have given less of his knowledge, or of his executive ability, to the service of the one employer than to that of the other?

To reduce the proposition to its simplest terms: Given the same management, the same results will follow no matter who furnishes the capital. Where municipalities have failed is just where private owners have failed,—either in lack of technical knowledge of the business or in lack of executive ability. And for each municipality which Mr. Ayer will name, that has been led into an unprofitable investment by the "ubiquitous politician" in conjunction with the iniquitous electrical salesman, I will show him (a) one company which has been put into the very same slough by the "leading local electrician" in combination with the salesman aforesaid; and (b) another company whose business has been spoiled not by the municipality under whose franchise it operates, but by

illegitimate private competition; which competition a municipality need never suffer from.

Next, I want to reiterate that Detroit was and is an exceptional case, both in the conditions of its local lighting companies and in its organization as a municipality. The circumstances which led to the establishment of a municipal plant here may never be duplicated in the experience of another city; and conditions equally favorable to non-political management exist in few cities of this size. Therefore municipal lighting should not be prescribed as a universal panacea because of its initial success in Detroit—not even because of its continuing success years hence. Every case must stand on its own conditions.

It is from knowledge of the local conditions that I venture on prophecy in answering Mr. Ayer's inquiry, "What is it reasonable to expect as an average cost for the next five years under municipal management?" I say that the average cost will be practically the same as it is this year. And I differ from Mr. Ayer as follows:

To begin: I renounce Whipple and all his works. So did every man now concerned in Detroit lighting, ever so many years ago.

Next: Detroit is not Chicago, neither like unto it; therefore reasoning by analogy is impossible. Chicago gets better service in its municipal lighting than it deserves, and it can get no better until it regenerates the very roots of its municipal system. I know also a little of that city, for I dwelt therein during certain recent years, and I want to say that no Moses ever sought to lead out of the wilderness a more perverse generation than that which has strayed behind Mr. Barrett. And I doubt whether Mr. Ayer, or my humble self, or any man who ever managed a lighting project, could have hustled or coaxed them further on the way than has their present leader. *I* would have quit trying long ago.

But while Chicago is discussed, let me ask, What is wrong with the municipal lighting of the South side parks and boulevards? That management is not hampered by politicians and political corporations, and the results are more than creditable; so that even Chicago shows in one spot the success of business management combined with municipal ownership.

Now to deny an implication. Mr. Dow does not now and never expects to assume that operating, maintenance, and interest for any period, either three months or longer, represent the total cost of municipal lighting or that the taxpayers of any city should be so instructed. He took particular pains to label plainly with name and date all the figures he ever gave out for publication, so that the newspaper man and also the wayfaring electric light man should read and not err; and should take those figures and add thereunto depreciation and taxes and insurance and water rent and (if so minded) the cost of buying Aldermen, and of standing off the opposition company; and play tag with the figures aforesaid to his heart's content. That's what figures are published for, anyway.

But Mr. Dow does assume, and sticks to it, that the "fixed policy" (in quotation marks) of keeping up every piece of apparatus to its original efficiency at the cost of operating account is the true way to work a "maintenance account"; and he further sticks to it that the expenses of this class charged to Detroit operating in the last three months are to all intents one-twentieth of the expenses so chargeable for the next five years. Furthermore that if the apparatus be kept up to its original efficiency, the cost of its operation cannot but continue the same.

Mr. Ayer is confounding the operating efficiency of apparatus with its value as a marketable asset. The two terms are originally related, but are not identical. And the first is immediately related to the "maintenance" account, while the second is related to "depreciation." Thus, if apparatus is maintained in such condition as to serve its original purpose with its original efficiency, the maintenance account is satisfied. But if the apparatus has to be so renewed or improved or added to, as to have an actual market value, in the current market, equal to its first cost; or if an account is opened to which is transferred year by year the difference between first cost and present market value, such expenditure or such account is "depreciation."

This last account is analagous to the putting up of margins in a stock deal. Of course, if a man owns the stock outright, and does not want to sell, the margins would only be on his own books and would be merely an interesting piece of mathematics until his heirs came to realize on the estate. A city corporation does not anticipate an administrator—its life is continuous—its franchise never expires.

Still the taxpayer should not (and does not, in Detroit) forget that he is liable to assessment for improvements or even for the making of repairs of the cumulative kind—on boilers for instance, on which the annual repairs are trifling for twenty years or so, after which a whole battery may have to be replaced or rebuilt because of the gradual reduction of the thickness of shells. The stockholder in a private company is liable to assessment in a precisely parallel way. Yet not one private company in a hundred thinks it necessary to put away in a strong box 5 per. cent. annually of the value of its boilers to provide for this twenty-years-distant occasion. This is what municipalities are asked to do, for the reason assigned that in contract lighting the contractor has to collect such a price as will ultimately cover the expense.

What I protest against is not the estimating of either a theoretical general depreciation factor, or of a charge to provide for keeping the plant "up to date"—a true "maintenance" charge is as already stated, a proper part of operating expense—but I want the depreciation cared for in the same way in the public case as in the private. To add 5 or 10 or 15 per cent. of the investment on to municipal annual costs is not the way to estimate a 5 or 10 or 15 per cent. depreciation. Because, in the municipal plan, the 5 per cent. stays in the hands of the taxpayers and is invested and re-invested and multiplied many times in the active business of each individual long before the twenty years expires. And because, conversely, the stockholders in the private company either re-invest their surplus over dividends (which is their depreciation fund) right in the company's business, or else divide it and use each man's share in his own affairs. The latter is the exact equivalent of the method in municipal lighting. The surplus need not be collected from the customers and divided among the stockholders because customers and stockholders are, man for man, and interest for interest, the same persons.

I have said that the taxpayers should not forget this feature of the business, and Detroit taxpayers do not forget it. There is little danger of their forgetting it so long as they have kind friends like Mr. Ayer and many others to remind them of it in the daily and weekly press. I do my share of reminding, when occasion offers, both in the press and out of it. They generally tell me (as one did to-day) that they prefer their depreciation fund left in their own business till the lighting plant needs it, rather than kept in a bank vault or in interest bearing securities, as is our city sinking fund; and much rather than in the coffers of some other fellow awaiting the time for the rehabilitation of the other fellow's electric lighting investment. The education in public lighting of Detroit taxpayers has been very thorough since those long departed days of Whipple.

Now as to the political "barnacles." I can tell the facts not only of three months but of thirty months' personal experience in hiring and discharging men for the engineering, construction, and operating divisions of the Detroit public lighting plant. The operating dates back over nine months—not three; the three months is the time since all contract lighting ceased. My experience is that "barnacles" do not apply any more, and have not for these two years. My early experience was that I got a few of them and summarily bounced them before they got their grip

made good. And the authorities approved of the bouncing. Also I find that non-political and strictly business commissions of management are an actual living reality of nearly three years in municipal lighting, and of a much longer time in other Detroit departments. Why should this not continue? A city gets just such government as it deserves; and so long as leading citizens—active men of business, of the best commercial standing—are willing to take control of city departments, so long will the city have as good management of its civic affairs as is given to the private affairs of its citizens.

There are others of Mr. Ayer's premises or implications that require a brief notice, in closing this communication. The statement that Detroit's operating cost, plus maintenance, interest, sinking fund to extinguish bonds, and a 5 per cent. theoretical depreciation is practically $100.00 per arc per annum, is substantially true. And it means that Detroit gets a 450-watt arc, keeps the plant in good running order, pays interest on bonds and creates a sinking fund to wipe out the bonds at maturity, and has another fund distributed among the taxpayers which will from time to time rejuvenate the plant, all for some $30.00 per annum less than it paid for a 360-watt arc "under competition between contractors." The demands which he says the plant "cannot meet" are the demands which under the contract system invariably swelled the annual lighting fund way above the contract by the promiscuous ordering of new lights to please "constituents." These demands could be met easily enough by a plant which has a duplicate boiler equipment and keeps a spare 350 horsepower engine and four dynamos turning over slowly during the early hours of the night to prevent (if possible) even one minute's extinction of street lights. It is not a case of "cannot meet" but *will not meet unless provided for by annual estimate.* And as to that contemplated expenditure of $150,000; when the estimates therefor shall have passed the Lighting Commission, the Common Council, and the Board of Estimates—the two latter being elective bodies—it may safely be believed that the authorized expenditures will not only be approved by the taxpayers, but will represent a profitable investment of public money.

DETROIT, MICH., Jan. 22, 1896.

AYLSWORTH'S NIOBIUM INCANDESCENT LAMP.

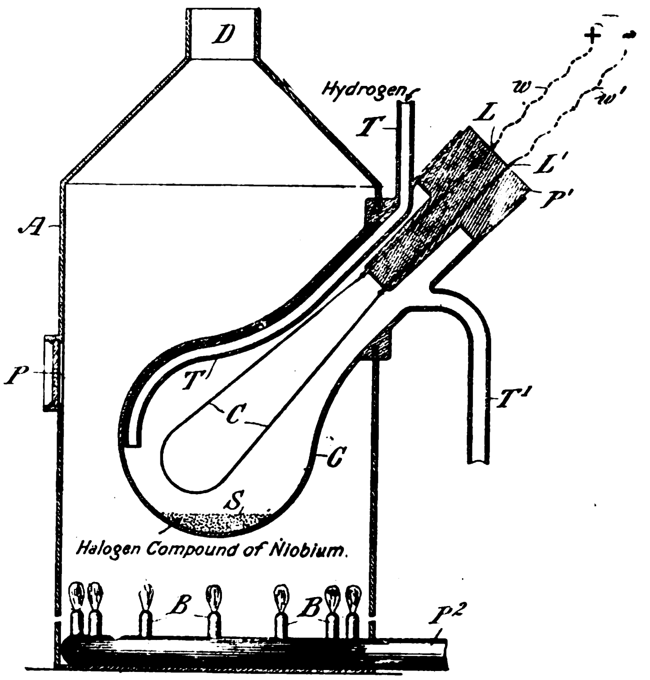
THOUGH carbon still maintains its hold as the material for incandescent electric conductors within lamps, nevertheless, attempts are still being made to substitute metallic filaments, of high melting points. The most recent work of this kind is that of Mr. J. W. Aylsworth, of Newark, N. J., who makes the incandescent conductor from such refractory metals as niobium, tantalum, molybdenum, titanium, zirconium, and other metals of the same group.

The method by which the filament is prepared consists in heating a base or support in the vapor of a volatile halogen compound of the element which it is desired to deposit, and simultaneously mix it with a reducing-gas, such as hydrogen.

In actual practice the process is carried out by means of the apparatus shown in the accompanying engraving. As will be seen it consists of a heating chamber A, provided with an outlet D for the products of combustion. The tube T admits the hydrogen gas under pressure and T′ conveys away the resultant gases or vapors.

Mr. Aylsworth takes an ore of the metal to be treated—such, for instance, as columbite, a well-known ore of niobium—and treats it by the well-known chemical process for separating the oxides of such metals and obtains in this manner niobium oxide. After the oxide is thus separated from its ore it is converted into a volatile halogen compound by the well-known application of mixing such oxides with charcoal and heating to a high degree of temperature in a current of dry halogen gas, such as chlorine or bromine. This halogen compound S is seen in position in the retaining-vessel G. The retaining vessel and its contents is then submitted to the heat of Bunsen burners and simultaneously a stream of a reducing-gas, as hydrogen, is passed through the chamber by way of the inlet and outlet tubes T and T′. A sufficient current of electricity is then passed through the conductors *w w* and the carbon or other base or support C to heat it to incandescence without rupture. There results from the union of the hydrogen gas and vapors arising from the halogen compound a deposit of the pure metal, as niobium, upon the filament base C. This process is continued until the deposit reaches the desired thickness.

Halogen compounds of any of the highly-refractory



AYLSWORTH'S METHOD OF PREPARING NIOBIUM LAMP FILAMENTS.

metals above referred to or any of the equivalent highly-refractory metals may be used in place of the halogen compound of niobium and the pure metals thereof deposited in the manner indicated. Mr. Aylsworth has succeeded in depositing in this manner tantalum, niobium, molybdenum, titanium, and zirconium, continuing the process in each instance until the carbon core or other conducting filament is surrounded by the metal.

A niobium lamp prepared in the manner described above has been run on test for some months past and shows very high efficiency and long life.

JAMESTOWN, DAK., ARTESIAN WELL LIGHTING.

A special dispatch from Jamestown, Dak., says: This city is struggling with the electric light problem and the proper degree of illumination of its streets. Pending the settlement all lights have been turned off. Up to January 1 the city paid $8 per month per light burning to midnight only. This rate is considered excessive. The city now has a fine supply of water from a 8½-inch artesian well, which is used for fire protection and also to furnish power to about twenty water motors in the city. Already the power of the well is taxed to the utmost and municipal electric street lighting is being considered in connection with the sinking of a proposed six-inch well. Such a well would furnish power to run an electric light plant, and the first cost of well and electric light plant would not be excessive.

CITY PLANTS NEVER DEPRECIATE.

The comptroller has purchased a draft for $1,900 and sent it to the Fort Wayne Electric Corporation in full payment for the new electric light machinery in the city station. By the way, the old dynamos are still in stock and can be purchased at a bargain. If anyone has a desire to invest, perhaps the caucus 18 can show them where there is a snap in the machinery.—*Bay City, Mich., Press.*

THE COST OF INCANDESCENT LIGHTING FROM CENTRAL STATIONS.

WE have received from Prof. W. D. Marks, president of the Edison Electric Light Co., of Philadelphia, a copy of a letter written in answer to an inquiry from Mr. Edison, as to the cost of incandescent lighting, which, in view of its practical importance, we print below in full:

Referring to your inquiry touching the cost of producing incandescent electric light from this station, assuming that you can furnish it with a 16 C. P. lamp, 20 to the H. P., it has had my consideration, and I beg leave to submit the following reply, which I trust will cover what you desire to know, taking particular cognizance of the commercial side of the problem.

The attempt to deduce the cost of producing incandescent light and power from the electric currents of small stations or isolated plants is apt to lead to error because many factors which do not appear in the smaller plants are of great importance in the large installations.

The cost of a large distributing system in the streets, if promptly and thoroughly repaired at all points where weakness develops, is no small item. The taxation of corporations in Pennsylvania is very onerous, which is also true in many other states. The clerical force required by a corporation for the proper transaction of its business and for the measurement of current and the writing of bills for same is large and costly.

The legal expenses and the losses of money from bills unpaid by unfortunate or dishonest consumers, mount up rapidly. Advertising, rents and soliciting agents all add to what may be called the contingent expenses, which cannot be predetermined.

Finally, after a station has been in operation for about three years, the constant renewals and repairs to steam machinery and electrical apparatus form a considerable item of cost, which cannot be avoided, since the machinery must always be ready for immediate and perfect operation. It is only by constant and thorough renewal of every part of the machinery showing weakness that a station can deliver an *unfailing and regular light*, without which dissatisfaction arises and failure is certain to follow.

Taking the case of this station from July 1, 1894, to July 1, 1895:

The average number of lamps connected is...	89,359
The total number of 16 C. P. lamp hours sold is..................................	62,702,714
Gross income from light and power, one year	$411,315.80
Income per lamp attached..................	$4.60
Income per lamp hour ($\frac{447}{1000}$ Amp. hour) sold.	$\frac{656}{1000}$ ct.

The expenses of producing light may be divided, approximately at least, into two classes: 1. Fixed charges, amounting to an annual charge on each lamp. 2. Proportional charges, varying with the amount of current produced. Neither one of these classes can be accurately separated from the other.

It may, however, be assumed that when a station has about 100,000 lights attached, that up to 150,000 lights, the following accounts will not be much increased, if at all:—Salaries, Rent, Insurance, Taxes and Royalty, Interest, Discount and Exchange, Office Expenses, Workshop Supplies and Expenses, General Expenses, Dynamo Room Pay Roll and Repairs, Engine Room Pay Roll and Repairs, House Wiring Inspection, Meter Expenses, Repairs to Electrical Apparatus, and Street Repairs and Maintenance.

The following expenses increase with the current sold by the station: Oil, Waste and Packing, Lamp Renewals and Coal. (In coal is included all its labor, handling and firing it and repairs to boilers, as well as to removal of ashes.)

The aggregate of the Fixed Charges is......	$132,677.99
An average cost per lamp attached of......	$1.46 per year
The aggregate of the proportional charge is..	$88,132.78
An average cost per lamp hour sold........	$\frac{1405}{10000}$ ct.
Average burning of lamp per year..........	701.7 hours.
Average cost of lamp per year, proportional charge..................................	98.6 cents.

Thus on one year's business,

Income from each lamp per yer..........		$4.60
Fixed charge on each lamp per year......	$1.48	
Proportional charge on each lamp per year,	.99	2.47
Profit on each lamp per year............		$2.13

Or, reducing to Lamp Hour standard,

Income from each lamp per hour.......		.656 ct.
Fixed charge on each lamp per hour....	.21 ct.	
Proportional charge on each lamp per hour..................................	.14	.350
Profit on each lamp per hour...........		.306 ct.

This analysis of the actual expenses of one year's run with 89,359 lamps enables us to look into the proper method of increasing the profits of this station.

If we increase the number of lamps attached without increasing the number of lamp hours averaged by each lamp, the profit arises from a diminution of the fixed charges per lamp. Thus assuming 120,000 lamps attached, the result is as follows:—

Yearly income from each lamp............		$4.60
Fixed charge each lamp....................	$1.11	
Proportional charge each lamp............	.99	2.10
Profit..................................		2.50
Total profit, 120,000 lamps................		$300,000

This is the limit of profit of station, machinery and conductors, as at present installed, provided the average hours of burning are not increased.

We have, however, room for machinery for 150,000 lights attached.

Estimated value of machinery for 30,000 lights attached..............................	$125,000.00
Additional street conductors................	125,000.00
	$250,000.00

The average hours of burning per day of lamps, from which we have deduced the cost per lamp hour, is nearly 2 per day.

An investigation of the possible profit arising from increased hours of burning will show the advantage to be reached by long hours.

FOR 120,000 LAMPS ATTACHED.

Hours use.		Income per year.	Cost per year.	Profit per lamp per yr	Total annual profit.
Per day.	Per year.				
2	730	$4.79	$2.16	$2.63	$315,600
4	1460	9.58	3.16	6.42	770,400
6	2190	14.37	4.18	10.19	1,222,800
8	2920	19.15	5.21	13.94	1,672,800
10	3650	23.94	6.23	17.71	2,125,200
12	4380	28.72	7.26	21.46	2,575,200
24	8760	57.46	13.41	44.05	5,286,000

The large results from long hours of use point to great concessions which can be made for long hours of motive power work.

The present investment of $2,000,000 should not, for obvious reasons to all business men, declare a dividend greater than 10 per cent., or earn a profit greater than 15 per cent.

This makes, with $2,000,000 investment and 120,000 lights attached, $300,000 per annum.

Our present minimum rate yields per year.........	$3.18
Cost per year..	2.10
Profit..	$1.08

A yearly profit of $128,600.00.

Long hours of use of current point to large concessions in the way of discounts, which will enable the cheaper use of power and light.

FOR 120,000 LAMPS ATTACHED, $300,000 ANNUAL PROFIT.

Hours use.	Annual profit at present rate.	Discount to reduce profit to $300,000.
2	$315,600	None.
4	770,400	60%
6	1,222,800	75%
8	1,672,800	82%
10	2,125,200	85%
12	2,575,200	88%
24	5,286,000	94%

As the machinery of this station is estimated to carry one-half the lamps attached, 24 hours with 120,000 lights is impossible. Likewise an average of 4 hours for the whole number of lights practically means 8 hours for one-half that number, and therefore the discounts should be one-half that shown in above tabulation.

Therefore, in making contracts for long hours of use of motive power or light, the discounts should be as follows:

YEAR OF 365 DAYS.	DISCOUNTS.		NET PRICES.	
	Per lamp per day.	Per H. P. per day.	Per lamp hour.	Per H. P. hour.
Minimum Charge.......	1 cent.	10 cents.		
2 hours..................	None.	For 2 H. P. & over, none.	¾ cent.	7½ cents.
4 "	30 per cent	30 per cent.	.525 "	5¼ "
6 "	37½ "	37½ "	.469 "	4.69 "
8 "	41 "	41 "	.443 "	4.425 "

The foregoing has been upon the assumption of a 50-watt, 16 C. P. lamp, and points out very clearly the existing costs, their nature, and under what conditions it is possible to reduce the cost per lamp hour by suitable discounts, without loss to the station or company.

Taking up your suggestion of 20 lamps to the H. P., equivalent to 37½ watts per lamp; this station, which can carry 150,000 lamps of the present economy of 50 watts, should be able to carry 200,000 lamps of 37½ watts and 16 C. P.

The aggregate of the fixed charges for one year on this station is $132,677.99, which would give an annual charge on each attached lamp of 66 cents.

The average cost of the proportional charge, due to coal, oil, waste and lamp renewals, should be ¾ of .1405 cent, or .1053 cent per lamp hour sold, assuming these lamps to have the same life.

Thus on one year's business the fixed charge on one lamp attached would be 66 cents; and assuming that each lamp burnt 701.7 hours, the total proportional charge is .1053 × 701.7 or 74 cents, which, added to 66 cents, already charged, would make $1.40 cost per annum, without any increase of the investment beyond $2,250,000, shown above. Assuming the profit required on $2,250,000 to be 15 per cent., we would have as the profit required of the station, $337,500.

The cost of running 200,000 lamps would be $1.40 × 200,000 or $280,000. Adding this to the profit required, we have $617,500 as what should be produced as a gross income from 200,000 lamps, or requiring $3.08 gross income from each lamp.

Assuming that these lamps burn (as learned from experience) 701.7 hours each year, the charge per lamp hour would have to be about .43 cent, equivalent to a gas charge of 86 cents per thousand cubic feet, to produce 15 per cent. profit on the invested capital, $2,250,000.

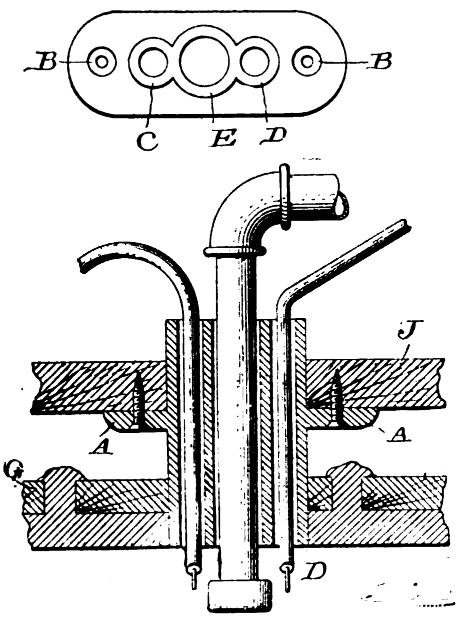
This, I believe, answers the questions which you have asked, assuming that lamps at 20 to the H. P. are burned the number of hours found as an average at this station.

The matter of discounts from long hours of burning will require similar treatment to the case I have already stated for lower economy lamps.

THE CASE OUTLET INSULATOR.

THERE is yet much room for improvement in house wiring appliances, and a step in the right direction has been made by Chas. F. Case of Akron, O., by the invention of an outlet insulator designed to protect wires at outlets, a matter that has perhaps caused as much trouble between wiremen and inspectors as anything else.

As will be seen from the illustrations it provides for bringing



FIGS. 1 AND 3.—THE CASE OUTLET INSULATOR.

the wires through porcelain tubing and keeping them rigidly the proper distance apart, the whole being made in one piece. In Fig. 1 and 2, C D are the tubes, A the plate connecting them together; B B the screw holes by which they are fastened to the lath or ceiling; and E a centre hole between the tubes allowing it to be put on over a gas pipe.

While the device is useful in keeping wires away from the gas pipe it is especially useful in keeping wires the proper distance apart and holding tubes in place where there is no gas pipe, in which case the plate *b* rests on top of the lath.

UTILIZING THE SCORCHER.

Various devices have been invented for enabling the cyclist to train or take his exercise indoors during bad weather. It has occurred to a French electrician that he might at the same time be doing some useful work. Accordingly, an apparatus is described in *L'Etincelle Electrique* by which the driving wheel of a safety bicycle of the usual type is raised from the floor and by means of a strap and speed gearing drives a small dynamo which is used to charge accumulators. The arrangement is designed to give a current of seven amperes at 20 volts.

DENVER, COL.—The Mountain Electric Co. has received a contract for lighting the capitol with two Western Electric direct-connected multipolars and Armington & Sims engines, to carry 2,000 lights.

LINCOLN, ILL.—The contract for constructing Lincoln's new electric light plant has been awarded to E. B. Herman & Co. The new concern will have one thousand incandescent lamps and the contract is to be completed in sixty days. The contract price is $2,200.

KEARNEY, NEB.—At the last meeting of the directors of the Kearney Canal and Water Supply Company and the Kearney Electric Company, Frederick K. Walbridge, of Brooklyn, N. Y., was elected president, in place of George W. Frank, Sr. Mr. Walbridge puts $50,000 into the business of the two companies, and promises that it will all be used for the enlargement and improvement of the business. Work will commence as soon as possible in the spring and be pushed forward as rapidly as consistent with good work.

NEWS AND NOTES.

THE UTILIZATION OF ACCUMULATORS AS RESISTANCES.

M. NODON directs attention to the advantages of using accumulators as a substitute for resistances in electric installations, in an article in the *Revue Internationale de L'Electricité*. It goes without saying that a considerable amount of energy is absorbed in resistance coils, which is irrecoverably wasted in heating the surrounding air. If a battery of accumulators is substituted for such a dead resistance, the electrical energy, instead of being lost, is in great part stored up in a form which may be afterwards utilized when required. M. Nodon quotes an example of an installation in which this principle was taken advantage of. A Gramme dynamo driven by a 2-horse petroleum engine gave a current of 30 amperes at 75 volts. This dynamo was coupled to four differential arc lamps arranged in parallel, and each taking a current of 8 amperes. Each of these lamps was fitted with a German silver resistance to reduce the voltage of the machine to the required amount. At one lamp the resistance was replaced by a battery of 10 Faure accumulators which were charged during the working of the lamp with a current of 8 amperes. The lamp with the battery was observed to work much steadier than those with the wire resistances, and sufficient energy was stored in the accumulators to light five 10-candle lamps during the whole night. With alternating currents it is proposed to use a rotary transformer to charge the battery. M. Nodon ends, however, by confessing that the use of accumulators as resistances is not likely to become general till their first cost and cost of maintenance has been considerably reduced, and expresses a fervent wish that this may soon take place, in order that their great advantages when used in this way may be realized.—*Lond. Elec. Rev.*

THUNDERSTORMS.

M. Albert Nodon has communicated to *L'Electricien* the results of certain researches made in connection with the department of physics at the Sorbonne. A Mascart electrometer was connected by a thin insulated copper wire to insulated metallic discs placed at some distance from each other in the open air, and it was found that the maximum potential obtained was the same during any one storm, and was independent of the distance of the disc from the spot where the lightning discharge took place. It is concluded from this that a thundercloud acts as an efficiently good conductor to be considered as presenting an equipotential surface, and that the electrical equilibrium, so far as the cloud is concerned, is rapidly re-established after each flash of lightning. It was possible to tell when a flash was about to occur by noting the rate at which the electrometer readings progressed towards the maximum.

CONTINUE TO DO GOOD.

I am glad to have an opportunity to speak my praise of the article on Edison station methods in your issue Jan. 8th. Trust you will continue on in such journalism.

W. E. HARRINGTON.

PHILA., Jan. 24, 1896.

Power Transmission.

THE SCHOENENWERD, SWITZERLAND, 3-PHASE INSTALLATION.

THE boot and shoe factories of Messrs. Bally & Sons, situated in the vicinity of Aarau, are among the largest in the world, the daily output of 6,000 pairs of shoes and boots, of all conceivable kinds and sizes, being exceeded only by a factory in the United States. The principal of the three factories, employing 4,000 hands, is situated at Schoenenwerd, near Aarau, on the

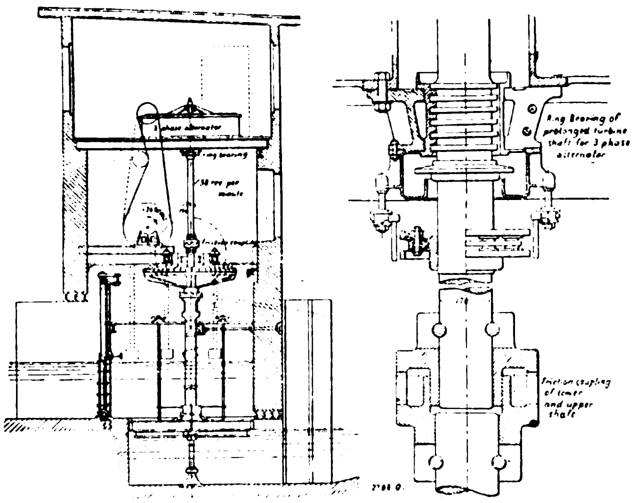
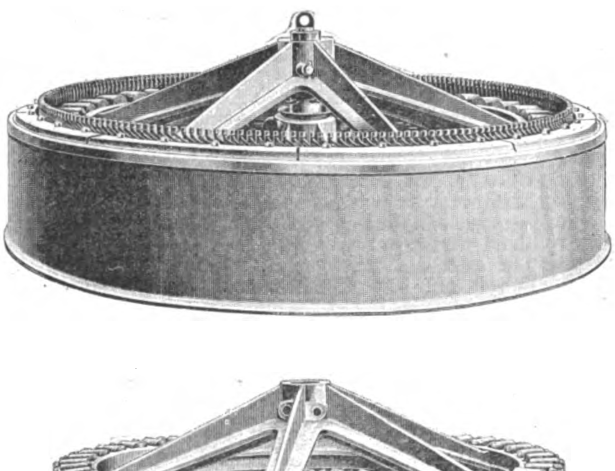


FIG. 1 AND 2.

River Aare, on the Zurich, Berne and Geneva trunk railway. This factory was until recently equipped with a Jonval low pressure turbine driving continuous current dynamos which furnished current for lighting and for one 24 H. P. motor and two 10 H. P. motors in a branch factory one half mile away on the other side of the Aare, while during spare hours, it charged a battery of accumulators for lighting dwelling houses near the factory.

For the better utilization of the power a 3 phase distribution was resolved upon with a 100 H. P. 3-phase generator, mounted direct on a prolongation of the turbine shaft and the new dynamo shaft is shown in the illustrations, Figs. 1 and 2. The

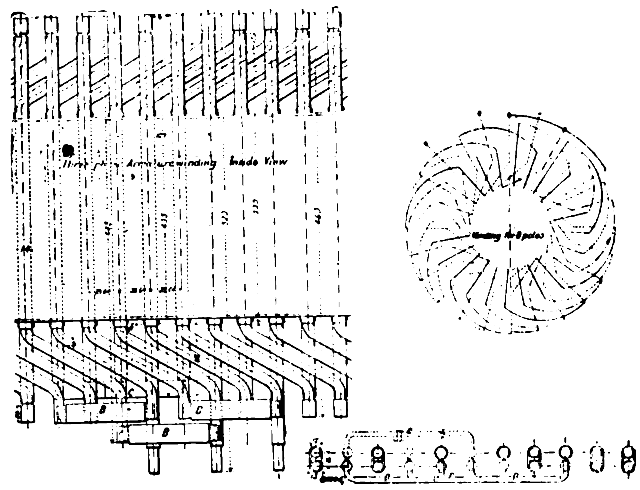


FIGS. 3 AND 4.—BROWN THREE-PHASE ALTERNATOR.

turbine wheel is 3.6 metres (12 ft.), the upper shaft 17 centimetres (6.7 in.) in diameter. The weight of the dynamo of 8 tons on the shaft is not counterpoised, but is supported on ring bearings, as shown in the engraving. There are six rings running in a gun-metal bearing, and below the bearing there is a broad chamfered collar to catch the oil that runs through and direct it into a catch-dish. The old lower shaft of the bevel wheel is connected with the upper shaft by friction coupling (Fig. 2).

Three-Phase Installation (Figs. 3, 4, 5, 6 and 7).—This was carried out by Messrs. Brown, Boveri & Co., and had to be adapted to more or less peculiar and complex conditions, viz.: in order to save space, and, moreover, loss by gearing, the alternator had to be mounted on the turbine shaft, making only 80 revolutions per minute, involving very low periodicity; and in order to be available not only for power, but to a small extent also for lighting without transformers, it had to be designed for low voltage. The machine consists of a circular gun-metal frame carrying the stationary armature, and of an inside six-armed spider flywheel carrying the rotary magnetic field, the latter being 2.7 metres (8.9 ft.), the former 3.15 metres (10.4 ft.) in diameter. The magnetic field is shown in a separate illustration, Fig. 4, and is composed of no less than 80 rectangular poles cast with the rim of the spider wheel. Forty of these pole-pieces are naked, while the 40 intermediate ones carry insulated wire coils wound on paper frames which fit the pole-pieces. To prevent the wire coils from moving or becoming loose, there is fitted and screwed to every adjoining naked pole-piece a rectangular brass guard frame or shoe whose wings extend to the edges of the two adjoining pole shoes, and press against the wire coils, thus holding them securely in position. The armature coil, clamped between the inner rings of the frame, consists of insulated laminæ of sheet iron with a double row of circular equidistant holes near the periphery, into which are inserted insulated copper bars in two rows of 240 bars each.

The upper and lower ends of every pair of front and back bars are respectively soldered together, the back bar having its upper portion bent in one direction, while the front bar has its lower portion bent in the opposite direction, as shown in the diagrams, Figs. 5 and 6. The arrangement thus constitutes a drum rather than a star winding, and is also shown, for eight poles, in diagram



FIGS. 5, 6 AND 7.

Fig. 7. At 80 revolutions per minute, or 0.5 revolution per second corresponding to $0.5 \times \frac{80}{2} = 20$ cycles per second, the output of the machine at 178 volts is 250 amperes multiplied by 1.73 for three phase, or 74 kilowatts or 100 horse-power. The exciting current is derived from a 40 horse-power direct-current bi-pole dynamo, already mentioned, which makes 670 revolutions, and is driven by bevel gearing from the same turbine as the generating alternator. The excitation is 17 amperes at 200 volts, equal to 3.4 kilowatts, or 5 per cent. of the effective output of the alternator. The total weight of the machine is 8 tons, equal to 121 kilogrammes or 266 lbs. per kilowatt of effective output. The loss due to armature reaction is 3.85 per cent., and the efficiency, including excitation and all frictional losses, is $\frac{90}{100} = 90$ per cent., under all conditions of working.

Motors.—The three-phase generator drives in different parts of the factory ten three-phase motors, each making 600 revolutions per minute, there being eight motors of 10 horse-power, one of 5 horse-power, and one of 1 horse-power, total 86 horse-power. They run absolutely noiselessly, and easily give 50 per cent. above their normal power. One of the 10 horse-power motors drives by belt the fan of the hot-air heating apparatus, which can also be coupled to a small 10 horse-power impulse turbine working under a pressure of 75 metres (246 ft.). On one occasion the belt was taken off the motor pulley and put on that of the turbine and then back again in the writer's presence; the motor on being switched on again, attained its full speed in a little over a second. For some of the operations which require motors with very low voltage, transformers are used which convert the 178 down to 10, volts.

We are indebted to London *Engineering* for the above details.

ELECTRIC ELEVATORS, WITH DETAILED DESCRIPTION OF SPECIAL TYPES.[1]

BY FRANK J. SPRAGUE.

THERE has been so much written on the subject of electric elevators which is pertinent to the subject, that in presenting this paper I shall make free compilation from others, and, supplementing these extracts with some new matter, I shall by lantern views illustrate some details of the more recent machines, their methods of manufacture, and some steps in their development. The time has passed when any one can doubt that one of the most important applications of the electric transmission of power, and one in the number and variety of its applications already rivaling the electric railway work which has made such marvelous strides in the past eight years, is that of the operation of all classes of hoisting machinery. Some idea of the extent of the present elevator business may be gathered from the fact that in New York City alone there are not less than 5,000 elevators of various kinds, more, in fact, than there are street cars, and more people are carried vertically than there are horizontally.

Ignoring for the moment the specific methods of application, and discounting the difficulties naturally met in developing machines to do the duty required in modern office work, not alone the technical difficulties, but those commercial ones naturally met when a new company enters the lists with untried machines against the entrenched forces of existing industries, there was still much of encouragement to be derived from a backward glance at the industrial changes wrought in the last few years, and to all objections raised there came the natural queries: Is the elevator field, great as it already is, limited to the possible application of a water or steam motor? Is there no wider, no more universal application of power for this class of service than has hitherto been presented? Is the hydraulic elevator the one bulwark to stand up against the assaults of the electric giant? Does it present such fixity of design, unity of purpose, refinement of processes, economy of operation and freedom from accidents as to preclude improvement if using some other power?

Let us look at the record in other fields and ask: Why has the trolley system, born only eight years ago, driven the horse from the street? It involves great initial expense, the conversion, distribution and reconversion of energy. It faced all the powers of conservatism, ridicule and fear. It had to combat the allied forces of the Bell telephone interests tested by court action in over twenty States. It had the opposition of the strongest municipal and corporate influences. Every detail of the system had to be created, and yet it stands to-day unrivaled in its industrial progress.

Why is the same trolley system driving the cable to the wall, and why has its adoption marked the abandonment of a plant costing not less than $3,000,000, in the city of Philadelphia? Are there many more examples of the direct applications of force than the cable system, many closer connections between a great engine built for the highest economy and that which it moves?

Why is the steam locomotive giving way to the electric motor on suburban service? Is there any more direct example of the application of steam than is presented by a locomotive, the power of whose cylinders is transmitted directly to the drawbar through the intermediary only of a crank?

Why does the best shop practice dictate the abandonment of the slow speed highly economical Corliss engine and the direct application of power by belts and shafting, and adopt the high speed engine and direct-connected dynamo at a central station, with the conversion, distribution and reconversion of energy by a dozen different motors at a greatly increased initial expense? Is it for any other reason than convenience, reliability and economy of operation?

Why has every overhead crane builder in the United States within the past four years absolutely abandoned wire rope, square shaft and hydraulic transmission for the three-motor transmission which I advocated only nine years ago? It is because it is simpler, because it will cost less, or because it is more economical, more flexible, and because it answers the purposes better than the other and more direct systems. Why have the great central stations of the country adopted electricity for the transmission of power to the hundreds of industries within the radius of their supply, and into what form of energy is the power of Niagara being converted? In short, why is the transmission of power in almost every case where flexibility, convenience, economy, efficiency and reliability are required depending upon the electric method, not only in new work, but oftentimes to the replacing of older plants?

The elevator field, indeed, is a large one, and if the system is electric, then, considered from a commercial standpoint, there appear the following possible classes of work: 1st. High speed passenger service where no hydraulic plant is possible because of limited space. 2nd. High speed passenger service in competition with hydraulic plants, the electric plant doing equal duty, costing less, occupying less space than the hydraulic, and costing much less to operate. 3rd. Substitution of new high-speed electric service in place of old steam and slow hydraulic services in buildings where the limited space and interference with operations will not permit consideration of a new hydraulic plant. 4th. Passenger elevator service in buildings where the loads are comparatively light. 5th. Passenger service in private houses where safety, simplicity and noiselessness are essential. 6th. Freight and special classes of work. For convenience we may classify elevator work as "first-class, that requiring speeds from 300 feet to 600 feet a minute," including the first three duties above mentioned, and as "second class, those requiring speeds of from 50 feet to 250 feet a minute," which include the remainder.

In general, there has been required and developed two kinds of machines to perform these services. The first is the outcome of the increased height of buildings and the demand for high speed and smooth motion, largely regardless of cost of apparatus, space occupied, or cost of operation. The hydraulic elevator was the result of this demand, and was the only one that up to a year or so ago was accepted for this service.

It was to meet this demand—by creating an electric elevator which would do the work equally well, if not better, than the hydraulic—that the elevator to be more specifically described, was developed under some unexpected difficulties.

Of course, such a machine must have the speed and capacity of the hydraulic elevator. It must be absolutely safe. It should have advantages in the matter of space, and must be more economical to operate.

The second class of elevator work, that which requires lower speeds, is applied to small apartment houses and other buildings where lighter elevator duty is required. This, for a long time, has been fairly supplied by worm gear elevators, and the replacing of the steam engine by an electric motor has enormously broadened the field for this class of machine. These two machines, however, are not equivalents. They present two distinct kinds of rope movement, two absolutely different methods of control, and two varieties of safeties.

Just here I will briefly outline some of these differences, for they constitute in my mind vital essentials, and are absolutely determinate in their limitations. The rope movement on the hydraulic is provided by an expanding set of sheaves on which all the ropes are maintained in fixed planes. Four to six ropes can be used on the machine, and six to eight on the car. The sets of rope can be equalized at the machine, and they have a fixed lead in the hoistway. The machines can be double and treble decked, and they have absolute limits of mechanical travel. All of these features are of the greatest importance when dealing with high lifts, large powers and fast travel.

The drum machine, while having a distinct field of its own, and a most useful one, has not a single one of the characteristics mentioned. It cannot well use over two ropes on the drum, and they cannot be equalized at the machine. The lead is a shifting one, and on long lifts this may be as much as from four to five feet. These particular objections have been met in a type of machine which may be called a cable drum machine, where the drive is by friction of the rope in the sheave grooves, but in both these machines, the plain drum and the cable drum, there is the very grave objection that there are no fixed limits of mechanical travel which are independent of the armature movement, and on fast speeds particularly, this is absolutely essential.

In the drum machines the driving power is applied through one or more worm gears. In my own practice on light service, such as house automatic machines, and a low class of freight work, I use a single gear with double ball thrust bearings, and on heavier work, a right and left handed gear generally cut on the Hindley form, to give the fullest amount of gear surface, and with the shafts connected by independent machine-cut spur gearing, which allows the worm gears to be free from each other.

There is another distinction—that of control. The hydraulic machine is necessarily a gravity machine, using power only in hoisting, its speed on the down side being controlled by the rate of water exit. The machine is, of course, under counter-weighted. In the drum machine, when there is any attempt at economy, over counter-weighting is generally used, part from the car and part from the back of the drum, the over counter-weighting being approximately equal to the average load.

With these two types of apparatus as precedents, the problem was:

How far can electricity be applied? What are the limitations of control? What the conditions of installation and operation, and to what extent could one type be eliminated? And the answer is: Both types must be used, but for distinct classes of service.

Taking the drum type and considering electrical control on a machine over-balanced for average service, the load up or down is sometimes with and sometimes against the machine. To control such a machine directly from a supply circuit (and I cannot seriously consider any other, no matter how ingenious or refined, as meeting general conditions), there is one method only, and that is the use of a rheostat in starting, and the inverse variation of the strength of the shunt field for about a two to one variation in speed. A cumulative series coil is only permissible in starting if variations of speeds are controllable, and in any event these variations are limited. Such a machine is, however, the best for second-class service.

1. Read before the American Institute of Electrical Engineers, Jan. 22, 1896.

Every one is familiar, of course, with the conditions of ordinary freight work. I might, however, here point out an important branch of this industry, and one which is destined for every wide application, and that is, automatic house service, the machine to be controlled without an operator, and so installed as to be as safe as a stairway.

Briefly, such a machine, on my system of working, is equipped with an interlocking switch device on the machine, having a coordinating movement with it, and with the controlling circuit in series with a number of door switches automatically opened or closed with the doors. The doors themselves are fitted with mechanical locks, allowing a car to be opened only during a range of movement from 6" above to 6" below. At each floor is a single controlling button. If the machine is at rest, the pressing of a button calls the car, wherever it may be, to the particular floor at which it is wanted, where it automatically stops. When the door is open it cannot be started, and when running, no one else can call it from the floor for which it is destined. The machine also has an additional control in the car, and the safeguards attending its operation are such as to make it safe for servant, nurse, child or invalid.

The development of the multiple screw elevator was undertaken for the express purpose of supplanting in a large way the former standard for high duty office service, and although not by any means an easy problem, either electrically or mechanically, a knowledge of what the hydraulic elevator is, and the variation of the types existing, gave adequate reasons for its attempt.

Let us consider for a moment a hydraulic system, and institute a few comparisons. It consists primarily of a steam cylinder, or a multiplicity of steam cylinders, working ordinarily under poor conditions of steam economy, that is, with a fixed cut-out in the high pressure cylinder of a compound pump or no cut-off in any cylinder of a simple pump. This element corresponds to the cylinders of a steam engine in the electric system, which use steam expansively with a cut-off varying according to the load, and under pressure conditions which are somewhat better than exist in a pump. It is to duplicate the results of this system of variable cut-offs and steam expansion, that the energies of the various pump builders have been more or less ineffectually bent for a great many years in plain acknowledgement of that defect in their simple and duplex pumps, the latter of which is common to almost every hydraulic plant of any size in the United States. It is true that a so-called "high duty" pump with equalizing piston is used on some of the larger elevator plants, but its use has not proven by any means entirely successful, because of the spasmodic nature of the service. Among the high duty pumps, the flywheel type, such as is used on large water pumping stations has been attempted, but rarely, I may fairly say, with success. The next element is the water cylinder, which corresponds to the dynamo in the electric system, and on account of the high friction due to the packing, the efficiency of a water cylinder with its valves is not ordinarily equal to that of a dynamo, which with a motor stands to-day the typical example of an efficient energy converter.

The next element is the piping and the tanks, compression or roof, and perhaps an accumulator, into or through which the water is pumped for delivery to the controlling valves of the elevator, and that which corresponds to this in the electric system is its simple wiring, and if a storage battery is used, then this last in conjunction with it.

Any competent engineer knows that, measured by standard practice, a given number of pounds of energy can be delivered to the controlling apparatus of an electric elevator for less pounds of steam, that is, water evaporated, through the medium of no less than fifty combinations of engines and dynamos, than can be delivered to the valves of any hydraulic cylinder through the standard pumps permissible in average elevator service. To be specific, the average water evaporation on a compound duplex pump, which is almost universally used, will in practice, be not less than about 60 to 70 pounds per horse-power of water energy delivered to the controlling valves, whereas the electric combination will easily give the same for less than 40 pounds. There are exceptional conditions in which a higher economy can be gotten in a hydraulic system, but they are few and are not typical, and under equal conditions the steam consumption in an electric system can be cut in two.

But this is not all. The fact is persistently ignored, although the attempt is made to offset it by recent experiments with a differential piston, that a standard hydraulic elevator uses the same amount of water under the same pressure for every foot of travel of a car, which volume of water and pressure are determined by the maximum load which has to be carried, although the average load on the ropes, including the excess of car over counterweight, is not over one-third of the maximum. On the other hand, the electric elevator uses, and must use, under normal conditions, current directly proportional to the work, modified in a small degree by starting and slow running. In short, over and above the friction load of the generating system, the steam consumption in the engines and the generation of electricity in the dynamo vary with the demand of the elevator machines. It is a system which is of necessity automatic.

On the other hand, the hydraulic system is one of the most flagrant violators of the relation which should exist between demand and supply. It is a system of transmission by water, having at one end a generating plant doing full duty for every foot of travel of its piston, with a variable duty on an elevator car at the other end, and an intermediate straight line water engine with its pipes and tanks taking care of that variable duty and using the balance of its energy in heating the water which passes through its valves.

Lack of economy, however, is not the only objection to the hydraulic system when looked at from the architect's or builder's standpoint. Until recent developments, these have always been strictly handicapped, not so much perhaps in the matter of cost, but in the internal arrangements of the building as well as in the lay-out of the basement, neither of which could be finally and satisfactorily, if even then, determined, until the particular type of machine had been accepted by the owner, and the contract finally made for it.

Nor has there been either singleness of design or unity of plan of operation. Each maker has had his own form of construction, his special method of control. Every building has brought up a problem more or less new, or at least conditions which had to be seriously considered in determining the elevator service. Horizontal and vertical machines, in basement or shaft; high or low multiplications; long and short, single and jointed cylinders; big and little diameters; large and small sheaves; free and suspended counter-weights; pulling and pushing machines; direct and differential pistons; roof tanks, stand pipes, accumulators and compression tanks; high and low pressures; hand rope, wheel or pilot-valve control; simple or compound pumps—all have made a nightmare of complications, giving more initial and continuing source of complaint and dispute than all the other engineering problems in a building.

So what more natural than that they should turn to electricity for emancipation? And this tendency is augmented by other reasons.

Leaving out central station supply, always, when properly equipped, to be preferred when the electric service is of a spasmodic or limited character, and considering for the present those large plants which characterize the modern office or hotel building and in a way rival central stations, every engineer knows that the fewer the number of well-proportioned units, the more alike they are, the freer the interchangeability between themselves, and the extent to which any one unit can be utilized, the better the system for power generation and conversion, no matter what its character.

The best modern practice makes a three-unit direct-connected engine and dynamo plant the best for lighting a building. There is an empirical relation existing between the number of lights required in a building as ordinarily designed, and the elevator service. When, in addition to the lighting service, such a building adopts electric elevators, it is not now necessary that it shall add an independent generating plant.

All that is required is that the three units should be somewhat increased in size and, perhaps, one of them preferably divided, the mains all taken to a common switchboard with two-way switches, and every engine and dynamo thus made interchangeable on either the lighting or elevator circuits, and at times both, especially if using a slow acting corrective converter, some of each can be run from the same engine and dynamo. So, instead of five or six units, some water and some electric, the entire generating plant is reduced to a single system consisting of three units of one size, or two of that size and two of a half size, which can be run interchangeably, and one of which is almost always in reserve.

Just here it is well to consider the probable application of the storage battery which, if built with plenty of lead, with large surfaces and for heavy momentary discharges rather than for long time steady discharges, will prove a most important adjunct to elevator service, which, like railway work, is spasmodic in character.

A modern office electric elevator on actual average service requires an expenditure of about one kilowatt hour per car mile of travel for every eight or ten feet of platform area. A car will make from 1½ to 2½ miles per hour, so that a battery of six elevators will run from 9 to 15 miles, although very rarely making over 12 miles per hour. With an ordinary car, say from 30' to 35' area, this would mean from 3 to 3½ kilowatt hours per car mile of travel, or say 35 to 40 kilowatt hours for a battery of six machines. Without a battery this would require a 120 kilowatt machine as ordinarily rated, worked at an average of 35 to 40 per cent. load. With a properly constructed battery a 60 or even a 50 kilowatt machine will handle the elevators.

Roughly speaking, a storage battery should be able to stand twice the dynamo rate for from three, to seven or eight seconds, and the dynamo rate for one-half a minute. If it has an hour discharge capacity equal to the dynamo capacity in kilowatt hours, it should be perfectly capable to run the Saturday, Sunday and night service required in an elevator plant without losing more than one-half its charge.

So much for the general conclusions on electric elevators, which are necessarily more or less brief.

To meet the hydraulic machine there was designed and devel-

oped what is now known as the Sprague-Pratt multiple sheave electric screw elevator, following the general lines of a tension hydraulic machine in the matter of rope movement, limit safeties and method of control. The net result has been, that this machine now stands the superior to the hydraulic elevator in that it has its speed and capacity with, if anything, greater safety, and certain advantages in its automatics. On high lifts it occupies less space; it is more flexible in its application, is more economical to operate, and it is more easily cared for.

General Description.—The machine may be described as the combination of two old elements with one new one, with specific safeties and methods of control.

Briefly, it is of the horizontal multiple sheave type, with a traveling crosshead and frictionless nut driven by a screw revolved by a motor directly connected, and governed by a pilot motor and rheostat. The general construction consists of a heavy main beam, carrying the traveling crosshead and the lower screw bearing, with special castings bolted at each end, one carrying the fixed set of sheaves, and the other the thrust bearing, brake and motor. The regulating apparatus is independent and self-contained, and is placed on the wall. From the car to the system of multiplying sheaves, the direct multiplying machine and the horizontal hydraulic elevator are practically the same. The crosshead, however, marks the point of departure in the two types.

In the hydraulic machine, this crosshead is rigidly attached to the end of a rod which terminates in a piston moving in a cylinder having an inside length equal to the lineal movement of the crosshead. This cylinder in the vertical type of hydraulics varies from 30 to 50 feet in length, with from 2 to 12 sheave multiplications, and in the horizontal types the multiplication runs as high as 14, with corresponding diminution of length of cylinder and increase in cross-section. Whatever the gearing, however, the length of cylinder is a function of the car travel. In this electric elevator, the crosshead being moved along a screw, stationary so far as the lineal movement is concerned, there is, with any given number of sheaves—only one variable—the length of screw; and, for all heights above about 100 feet, the electric machine has an advantage in matter of length, which, with increased rises, becomes of great importance.

Looking to the needs of office builings, there has been adopted two methods of rope multiplication, determined by the height of building, and so selected that the length of machine over all, shall not exceed about 30 feet for rises approaching 300 feet actual car travel. From this the length grades down to about 21 feet, so that all rises between 60 and 300 feet can be taken care of with an extreme variation of nine or ten feet in the length of machine, and there is thus provided limiting dimension data of great convenience and utility.

These systems of multiplication I may term direct and indirect. In the former, the entire multiplication, varying from six to ten, is done at the machine, and the ropes lead from the end sheaves over the shaft sheaves direct to the car. A free counter-weight is used, the ropes being fastened to the car frame. In this method, which is that common to all horizontal and to many vertical hydraulic machines, the hoisting and counter-weight ropes have unequal duty; furthermore, the ropes having the maximum bending, travel on the outboard sheaves at the same speed as the car. This last is the case also with all vertical hydraulics. In some of the latter, the counter-weight is carried in the cylinder on the piston, or in the strap, or both, its weight being as many times that of a free counter-weight as there are multiplications. Sometimes both methods are used.

Economy of operation and smoothness of movement, however, are antagonistic in their relations to the amount of counter-weight carried. The best method is probably that used when there is a single multiplication in the shaft, giving a two to one counter-weight traveling at half speed, and carried by all the car-hoisting ropes, as is done for short-rise vertical hydraulic elevators.

For long rises I have adopted a combination vertical and horizontal machine rope practice, giving even a more compact machine, a longer life of ropes, and better counter-weight results. In this indirect system there is a division of multiplication, which, while having the same effect so far as speed of car and length of machine are concerned as a high direct multiplication, has an entirely different result in the wear on the ropes and the amount of counter-weight which can be carried without jumping.

This is accomplished by making one-half the multiplication (6 or 8) on the machine, the ropes, properly proportioned, going thence to the bottom of the counter-weight frame, which has a single multiplying sheave on top. The car ropes go over the shaft sheaves, under the counter-weight multiplier, and back up the hoistway, where they are anchored, giving a car speed twice that of the counter weight. The equalizing chains, used to make the pull of the car with any given load constant at all points of the hoistway, are fastened to the bottom of the counter-weight frame and anchored in the hoistway. The space occupied by this multiplier is only two or three inches more than by ordinary form of counter-weight. A proportionally shorter screw, fewer revolutions, and sheaves of greater diameter, characterize this type of multiplying machine.

This system seems to be the best yet devised for long rises, for not only do all the car ropes do equal duty, both with relation to the hoisting strain and the counter-weight, but the rope wear must be less because of the division of speed and multiplication, the necessity of changing only one-half of the ropes at a time, and the possibility of reversal of the ropes on the multiplying machine to get a new wear. Where space is limited, I use a double decked machine, and in the new Commercial Cable Building, which is to be 21 stories high, the machines will be treble decked, and about 10½ feet in height.

Details.—Turning now to the detail construction and operation of this machine, there are a number of features claiming special attention, each unique in character, and marking a radical departure from all other elevator practice. These are the nut, screw, and thrust bearing, the brake, the motor and the regulator apparatus.

One of the most interesting as well as important features, and, perhaps, the one which has been most frequently attacked, is the nut system. It joins the crosshead of the traveling sheaves by a conical seat. There is no fastening between the nut and the crosshead, the continual weight of the car always keeping them in contact; and the friction at this point, being greater than between the nut and the screw, enables the latter to transmit a straight-line movement to the crosshead when the screw is revolved by the motor, and also to revolve the screw and drive the motor as a dynamo when the mechanical brake releases the screw to allow the car to descend. These are the normal functions of hoisting and lowering. There are several other distinct functions of this nut which will be described in considering the "safeties."

Continuing the line of transmission of power, the only points of contact between the interlocking nut and screw are by a chain of balls which occupy a number of threads, and enter and leave the ends of the nut through tubes which are connected together so as to make a continuous conduit. This is one of the most vital points of the elevator apparatus, and herein lies one of the most potent reasons of its success—the reduction of friction by rolling instead of sliding surfaces on almost all parts under pressure; for not only is the nut so constituted, being in fact a developed spiral thrust-bearing, but the thrust-bearing at the motor end of the screw is taken on balls and the sheaves are carried on ball or roller bearings. This nut being a vital part, its development has been most thorough, and a peculiar treatment of steel which has been adopted renders its surface so hard that the wear is very small, and it is well within commercial limits.

So free is the machine from static friction that it is possible to start the car with a very slight increase of current over the normal hoisting current, providing time be taken so that the work done in acceleration is small to the work of lifting, although that is not the usual practice.

The balls have an average crushing strain of 25,000 pounds each, but the working pressure varies from only 50 to 125 pounds per ball. The nut system is a compound one, for, besides the working-ball nut there is another, called the "safety-nut," to which I will make reference later, keyed to it, and between the two is a powerful spring under compression.

The screw is a forged bar of high carbon steel with a peculiarly shaped thread, the finished screw having a tensile strength of 700,000 pounds. It passes through the clearance hole in the steel trunnion crosshead, which carries the traveling sheaves, then through the nut, and is carried at the outer end by a fixed bearing. This screw is sectioned, being joined to the armature shaft by a cone-seated coupling, secured by a taper gib.

The in-board end of the armature shaft, which is, in effect, the extension of the screw, terminates in the thrust-bearing, where the pressure is taken by about 200 steel balls carried in a bronze guide plate and bearing, by specially hardened steel disks. The thrust of the screw being thus taken up on the in-board end, the strain on the screw is invariably between that end and the traveling crosshead—never beyond this; hence, it is always under extension strain—never under compression, and cannot buckle.

The action of the balls on the screw, which is untreated, is peculiar. They form a path for themselves, partly by wear, but principally by rolling compression of the steel, which finally becomes exceedingly hard, such that the edge of any ordinary machine tool would be turned. The balls themselves wear very evenly. Oblique forms in normal practice cannot exist.

Beyond the thrust-plates is keyed an iron pulley, connected by a flexible coupling with the motor shaft. The function of the brake is that of locking the screw when at rest, it is not a means of varying the speed. In case of accident, it has the additional function of helping to stop the screw. It may be described as a compound electro-mechanical brake. A steel brake band, wood-lined, is anchored at one end, the hoisting-side on the motor-bed frame, and the other end is continually pulled down by a powerful spring under compression. The mechanical movement in opposition is through the medium of a peculiar magnet. It is operated by a dual circuit, one in hoisting, another in lowering. In the event of failure of current for any reason, or too high a speed on the down run, this magnet releases the brake in the latter case by a snap switch, operated by an adjustable Pickering centrifugal governor driven by the main screw—and the brake

band promptly grips the brake wheel softly yet powerfully.

Motor.—The motor, which is of the multipolar type, is carried on the same casting which contains the thrust-bearing. The field magnets are of steel, and are excited by two circuits; one, known as the shunt circuit, being variable in strength at will, so as to vary the maximum speed of the machine, and the other, a series circuit, which acts to strongly compound the field. This type of elevators is differentiated from all other electrics by the fact that the action is like that of the hydraulic, for it always works against gravity. In hoisting, the motor takes current from the line, but in lowering, its main circuit is cut off from the line, and the motor, rotating in an opposite direction, is driven as a dynamo by the weight of the car. A strong element of safety exists in the fact that the current in the field coils is never reversed, and consequently the machine is never demagnetized. Hence, under certain conditions of the operation of the safeties, it has a power of self-excitation which is of importance.

The armature which turns in this field is of the ironclad type, and not liable to injury of any kind. It is mounted on a sleeve, is of the 2-path series winding, has a very large commutator, and, of course, multiple carbon brushes. The field coils can be removed without disturbing any other part.

Control.—Considered in its simplest form, and in connection with its action upon the motor and multiplying machine, without reference to the means of communication between the car and the regulator, this last is a very simple device. It is composed of two parts, each made up of peculiarly shaped iron grids of various sizes arranged in circular form, connected to copper contacts on a slate disc over which passes a heavy carbon brush.

The use of iron castings of a specific composition possesses great advantage over any form of wire resistance, not alone in the matter of cost. They are flexible, they expand in any direction readily, and, as made, they have a resistance of from forty to fifty times that of copper, or roughly, that of German silver. The grids are interchangeable, and any of them can be readily replaced.

One side of the rheostat is for regulation in hoisting, the other for lowering. Instead of moving this regulator by hand, it is operated by a pilot motor wound with a right and left handed field, one or the other of which only at a time, can be in circuit with the armature. This pilot is connected to the rheostat arm by a single reduction worm gear, and is operated either from the basement or the car, according to the position of the "change over" switch, by an "up" and "down" button with an automatic lever stop which normally has to be held by the operator to prevent the pilot returning to a stop position. The spindle of the rheostat arm operates switches co-ordinating in their movement, in turn controlling the magnetic make-and-break circuit switches, the down brake, and also the automatic stop lever switches which limit the pilot movement.

The use of magnetic switches instead of hand control switches not only removes the arcing from the face of the rheostat, but it gives the benefit of instantaneous cut-offs not possible by any other means of control. This, on fast machines, is of the utmost importance, and the practical application is that if a car is on the "up" motion, and an operator, because of carelessness or because of fright lets go his stop handle, the current is instantly cut off, the regulator following to stop, and the car is arrested in the shortest time practicable.

Assuming that the circuit is made for the up movement, it first meets with a resistance sufficient to about hold the car and lift the brake. This resistance is then gradually cut out, the torsional effort of the armature is increased, giving the car an upward movement with an acceleration depending upon the rate of movement of the rheostat arm, and with a final velocity determined by the point at which the arm is stopped. If, while hoisting, for any reason the current is cut off, the torsional effort ceases, the brake instantly comes into action and the car comes to rest.

In lowering, the brake is lifted by an independent circuit, but the armature is first short-circuited on itself, and becomes a most powerful dynamic brake. As the resistance in this circuit is increased, the car runs faster. When it approaches the lower limit of movement, an independent retarding circuit is established, and gradually reduces the resistance. This brings the car to the slowest movement. The pilot movement regulation is, to my mind, an absolute necessity of fast passenger work; and its application, although at first attended with a number of annoying difficulties, is to-day by far the most reliable method of control known.

Safeties.—Of course, the vital question to be considered in any elevator system is that of safety. In that respect, I think, we are amply provided. Safeties may be considered under two heads: First, those on the car, and second, those on the hoisting machine. On the car we use a special centrifugal which is attached to the lower section of the car frame. It consists of two long levers, short-fulcrumed at the sides of the car and operating clamping jaws which run in close proximity to the car rails, but normally out of contact with them. The inner ends of the levers overlap, and in action are pressed apart by a very powerful spring under compression. When out of action, these levers are drawn together, the spring is put under compression, and the system locked by a trigger. Near the trigger is a centrifugal governor, operated by a standing rope, which at a determined speed releases the trigger, frees the levers, and the safeties clamp the rails with a pressure of about 16 tons. This safety can be released from the inside of the car.

In the car, as has already been described, there is an automatic stop contact which operates to bring the regulator to the stop position and the car to rest in case the conductor removes his hand from the controller because of crowding, accident or carelessness. On the hoisting machine there are a number of safeties. One which is perfectly apparent is due to the fact that the crosshead is moved by a screw with a heavy armature on the end of it, which is driven through the medium of a nut by a car of limited driving capacity. The screw itself is of forged steel, under tension and torsion strains, with a safety factor of at least twenty to one.

The hoisting nut, as already described, is hardened by a specific process which makes its wear very limited. In addition to this, there is in the nut system what is called a "safety nut." Normally this is out of contact with the thread of the screw, but it is secured to the hoisting nut, and should any accident happen to the latter, breaking its hold on the screw, this safety nut, the threads of which interlock with the screw's threads to a greater depth than the thread of the hoisting nut, would then take the place of the hoisting nut and securely grip the screw. This would put the elevator out of operation because the friction between the nut and screw would be greater than the friction of the traveling crosshead, and it would act simply as a collar on the screw.

The nut system has in addition another function. Since the hoisting nut is only held from revolving by its friction against the crosshead, when the nut gets to the upper limit of its travel the safety nut meets a solid collar on the screw which stops its travel, causing it and the ball-bearing nut to revolve with the screw, without, however, necessarily stopping the motor, and leaving the traveling sheaves to be stopped simply by the weight of the car.

There is still another function performed by the nut system, that of a slack cable device. If for any reason the car in descending, when of course the nut is driven along by the screw, meets an obstruction, the pressure on the nut being instantly reduced, it recedes slightly, allowing the springs between it and the safety nut to expand, throwing the latter into back contact with the screw threads. The nut system then instantly grips the screw, revolves as a collar, and consequently acts as a check against any marked movement of the crosshead corresponding to a free fall of the car on the ropes. Assuming, however, the condition of a perfectly free release from all operative safeties, there is a limit to the rate of revolution of the screw, and in any event there is a rubber buffer at its lower end which would cushion its stop so as to prevent any injury.

Besides the lower limit switch, which has already been mentioned, which puts an increasing retarding force on the motor, there is an upper limit switch for cutting off the current; this is a self-cleaning lock switch, operating in both directions, and moved by a roll on the crosshead. It cuts off the current in hoisting in the upper limit and allows the brake to come on. On the reverse movement it is automatically closed.

I have already mentioned the governor on the machine, which is called a "monitor centrifugal." This is for operating the brake when running too fast. In hydraulic elevators there is no speed-operated device in case of fast running except the centrifugal on the car, and this is frequently set so much above the normal speed on account of the annoyance of having it operated by a temporary excess, as oftentimes to be useless when actually required. The monitor centrifugal does not throw the machine out of operation, but simply slows it up to any desired speed, and then allows the operator to resume control.

The dynamic action of the machine is made use of in still another way by the introduction of an "automatic choking circuit" and switch operated by the same circuits governing the main brake. It is in constant play and closes the circuit around the armature and its series coils through a rheostat under any of the following circumstances: At each stop from up or down; when running down fast enough to work centrifugal on the machine; on failure of the hoisting current, or on failure of the line current. So positive is the control over the motor, no matter whether it be operating to hoist the car or retard it in going down, that the brake band can actually be removed and the car still controlled, and even with the brake in normal position the change from one position to another can be made so promptly that it will remain inactive.

Such is the machine which has been developed during the past three years, and whose first application in a large battery in the Postal Telegraph Building seems destined to have the same effect on the elevator industry that the plant at Richmond has had on the railway industry. It is only permitted to me, of course, to make the briefest allusion to this, but as illustrating in some degree the extent of this industry, buildings of from five to twenty-one stories in height are being equipped with batteries of from one to twenty-six machines of various types, and the business of a single company employing some two or three years ago a hand-

ful of men, now demands a constantly increasing force already numbering nearly five hundred.

[The paper was illustrated by a large number of lantern views.]

SOCIETY AND CLUB NOTES.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—MR. F. J. SPRAGUE ON ELECTRIC ELEVATORS.

THE 102nd meeting of the Institute was held at 12 West 31st street Wednesday Evening Jan. 22nd at which a paper was read by Mr. F. J. Sprague on "Electric Elevators, With Detailed Description of Special Types," 150 members and guests being present. The paper was fully illustrated by lantern slides, and the practical operation of electrical controlling apparatus for elevators was shown by a working exhibit of the essential parts on the platform. The paper was discussed by Messrs. Steinmetz, Hill and Leonard but owing to the lateness of the hour further remarks were postponed until the next meeting.

At the meeting of Council in the afternoon the following Associate Members were elected:—E. B. Cunningham, Sup't Fort Dodge Light and Power Co., Fort Dodge, Iowa; C. L. Edgar, Gen'l Manager and Chief Engineer, Edison Elec. Ill'm'g Co., 8 Head Place, Boston, Mass.; Edward A. Evans, Acting Chief Engineer, The Quebec, Montmorency and Charlevoix Railway, Quebec, Canada; W. S. Franklin, Prof. of Physics, Iowa State College, Ames, Iowa; Walter L. Githens, Manager, H. P. Elec. Light and Power Co., 7284 So. Chicago Ave.—residence, 5101 Kimbark Ave., Chicago, Ill.; Zentaro Jijima, Assistant, Wagner Elec. Mfg. Co., 2017 Lucas Place, St. Louis, Mo.; Charles Lemon, Hon. Sec'y for New Zealand for the Institution of Elec. Engineers, Palmerston, North New Zealand; John E. Lloyd, Ass't Chief Engineer, Philadelphia Traction Co.—residence, 2008 N. 18th St., Phila., Pa.; Wm. E. Moore, Electrician and Sup't, The Augusta Railway Co., Augusta, Ga.; George P. Nichols, Partner, Geo. P. Nichols & Bro., Elec. Engineers and Contractors, 1036 Monadnock Build'g, Chicago, Ill; Wm. Bancroft Potter, Engineer Railway Dept., General Electric Co., Schenectady, N. Y.; Edward Andrews Wagner, Electrician, The Mexican International R. R. Co., Eagle Pass, Texas—residence, Coahuila, Mexico.

The following Associate Members were transferred to Full Membership:—Harry Bottomley, Electrical Engineer, Supt. Marlboro Electric Co., Marlboro, Mass.; George W. Gardanier, Electrician, Western Union Telegraph Co., New York City.

Approved by Board of Examiners, Dec. 5th, 1895:—Fred. A. Scheffler, Stirling Boiler Co., New York, N. Y.; Harvey Stuart Chase, Electrical and Mechanical Engineer, New York, N. Y.; Ralph D. Mershon, Electrical Engineer, Westinghouse Elec. and Mfg. Co., Pittsburgh, Pa.; Norman T. Wilcox, Manager and Electrician, Seneca Light and Power Co., Seneca Falls, N. Y.; Samuel Reber, Lieut. U. S. Army, Chief Signal Office, Washington, D. C.; Francis Jehl, Representative, F. Hardtmuth & Co., 60 Liberty St., New York.

NEW YORK ELECTRICAL SOCIETY.

The 171st meeting of the Society will be held at Columbia College, Madison Ave. and 49th St., on Wednesday, the 29th inst., at 8 P. M. Mr. Herbert Lloyd will lecture on "Recent Improvements in America and Europe in the Storage of Electricity." Mr. Lloyd, who is connected with the active management of storage battery interests in this country, has just returned from a trip to Europe, undertaken for the purpose of investigating all the recent work in progress there involving the utilization of stored electricity. Mr. Lloyd has a large amount of interesting and valuable information to communicate entirely new to the American electrical public, and will throw much light on the relative conditions of storage battery development, technical and industrial, in this country and on the other side of the water.

OBITUARY.

FIRST LIEUT. SWIFT, U. S. A.

First Lieut. Swift, of the Ninth Cavalry, United States Army, committed suicide at Fort Robinson, Neb., this month, by shooting himself through the heart. His suicide closes one of the most remarkable careers in the United States Army. From the position of telegraph operator in a small town of Virginia he became a private, corporal, sergeant and lieutenant in the army in as many days as there were promotions. When Gen. Myers organized the Signal Corps of the army, Swift had considerable local reputation as a telegrapher, and to secure his services as an instructor he was enlisted in the corps and promoted from day to day until he attained the rank of Second Lieutenant. After joining the corps and beginning his work as instructor he devoted himself to the study of electricity and telegraphy, becoming one of the most skillful operators that the world has ever known and an author on the subject.

There were a lot of fancy tricks in sending and receiving messages that Swift used to do. One of them was to take two messages at the same time. He could write equally well, and beautifully, with either hand, and could take a message from one instrument, writing it out with his left hand, while he copied another message with his right. He could also send a message with one hand while he received another message, copying it with the other hand.

LETTERS TO THE EDITOR.

AS TO A STANDARD LAMP BASE.

The question of standardizing lamp bases is certainly an important one and should receive the proper attention at an early date. Believing that opinions from everyone interested in such a matter will be a help in deciding a question of this kind the following ideas are presented.

The standard base should be of either the Westinghouse or Edison types;—the extra cost of the Thomson-Houston being the principal factor against its adoption. While there are doubtless more Edison bases in use than other makes yet the Westinghouse bases are very largely used on alternating circuits and the demand for them is certainly a good one. There is one feature about the Westinghouse base which is much in its favor as compared with the Edison. The majority of incandescent lamps are placed in a vertical position but a very large number are placed horizontally and this number is increasing daily owing to the adoption of incandescent lamps for signs and advertising purposes. The majority of lamps used in this way are of the 16 c. p. type. If lamps placed in this position are burned at full candle power the filament soon droops until it finally touches the glass and then it is generally but a short time before the lamp is burned out. Of course this drooping of the filament is easily remedied by using lamps with anchored filaments, but there are thousands of lamps used in a horizontal position which have the ordinary filament, particularly on test boards, where they are frequently subjected to extremely high voltages for a short time.

When a lamp has been burned in a horizontal position for a time, by turning the lamp in the socket the drooping filament can be brought on the upper side of the lamp, thus saving the filament from touching the glass and prolonging the life of the lamp. With the Edison base it is impossible to turn the lamps in this way, as the contact at the base of the lamp is then broken; while with the Westinghouse base this is easily done.

While this feature is in itself a small matter, yet it is worthy of consideration.

RUPERT A. JENKS.

PHILADELPHIA, Jan. 20, 1896.

A TREASURE IN THE LIBRARY.

I cannot too highly praise the position THE ELECTRICAL ENGINEER has placed itself in, in the hearts of the electrical fraternity. I have watched for the past nine years THE ELECTRICAL ENGINEER grow, and value it as a treasure in my library. The issue of January 8th is a high tribute to your ability. The article on the New York local Edison Co. is first class, and I would add that this is the character of reading which appeals to the practical man, and still more of it is needed. Wishing you continued and further success.

ALFRED E. BRADDELL, *Elec. Inspector.*

Underwriters' Association, Middle Dept.,
PHILADELPHIA, Jan. 23, 1896.

THE BEST MEANS OF KEEPING IN TOUCH.

It gives me great pleasure to renew my subscription to your most valuable paper, which I find is the best means for keeping in touch with the constant progress in the electrical arts and science. Allow me to congratulate on the Data Sheets, which have been introduced during the past year, and which mark, in my opinion, a great advance in the history of your paper.

HENRY J. SAGE.

ROCHESTER, PA., Jan. 20, 1896.

MOST COMPLETE DESCRIPTION EVER READ.

The January 8th issue of THE ELECTRICAL ENGINEER contains the most complete description of a central station I have ever read; and not only is it interesting reading but a collection of data on one of the most extensive plants in the country, that would probably never have been systematically brought together but for the efforts of your paper. I have already ordered extra copies. Accept my congratulations with wishes for your continued success.

GANO S. DUNN, *Elec. Engr.*

CROCKER-WHEELER ELEC. CO., AMPERE, N. J.

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CONTENTS.

A BILL TO VACATE PATENTS.

DURING nearly every session of Congress for the past fifteen years, attempts have been made to repeal all the statutes relating to the granting of patents by the United States, or to so modify them that the present rights of inventors would practically be legislated out of existence. These attacks on our patent system have almost invariably, we regret to say, come from the farmers and "grangers" who have felt aggrieved because they have had to pay a small royalty on apparatus, without which their crops could neither have been sown, raised nor harvested, yet who would deny recognition to the inventor who has not only benefited them directly but millions of his fellow men besides. Having made but small progress in the past in legislation intended to wipe the whole patent system out of existence, the enemies of the present patent law have hit upon another plan, which, under cover of giving the inventor some compensation for his work, nevertheless deprives him of the legitimate fruit of his efforts. An example of this is the Bill (H. R. 281) introduced by Mr. Lacey into Congress, which we here reproduce.

A bill to enable the United States to terminate and cancel letters patent for inventions in cases of general public importance.

Sec. 1. Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That any letters patent of the United States that may be hereafter issued to inventors may be terminated at any time by the enactment of a special Act or special Acts for that purpose, and from the date of the taking effect of such special enactment or enactments all rights under such letters patent shall cease and determine.

Sec. 2. That no letters patent shall be terminated under the provisions of section one of this Act unless a grant of not less than twenty-five thousand dollars nor more than one hundred thousand dollars shall be made in such special Act to compensate the inventor or his assignee or assignees for the loss of such patent: *Provided*, That Congress may further grant an allowance to any inventor, in the case of thus terminating a patent, for a sum equal to the amount expended by such inventor in perfecting his said invention.

This bill came up before the Committee on Patents to whom it was referred and Mr. Lacey himself spoke in support of it. It seems that his whole argument was against the "telephone monopoly," but those who spoke in defense of the patent system as it stands had no difficulty in showing the weakness of Mr. Lacey's position. If the view taken by the mover of the Bill be accepted, the Government, in order to be just, ought to guarantee something to those whose patents they do not take, or who cannot get them worked or introduced. A bill similar in its purport to that printed above was introduced some years ago by Mr. Hall, before his appointment as Commissioner of Patents, limiting the inventor's compensation to $25,000, but it was killed in committee. A similar fate probably awaits the present bill which, if enacted into a law, would practically amount to the confiscation of the inventors' rights. Nevertheless it would be well for all interested in patent property to address a word of protest to their representatives in Congress and thus put an end to a most pernicious measure.

But, that legislation, though of a different nature from that attempted as above, would be salutary for our present system of issuing patents is not to be denied. The weak points therein are well shown by Mr. W. C. Dodge, in an article printed in this issue, and to them is largely due the odium in which the system has fallen in some quarters. Section 4887, which has deprived American inventors of

large sums, rightfully due them, ought also to be stricken from the statute books or so modified that American inventors may not be punished for taking out foreign patents. Bills with these ends in view will, we understand, be shortly introduced into Congress, and inventors and manufacturers should unite in securing their passage.

LESSONS OF THE BICYCLE SHOW.

ANYONE who visited the great bicycle shows in Chicago and New York, particularly the latter which drew more than 100,000 people within Madison Square Garden, must have been impressed with the utter absence of monopoly and the consequent keen and active competition among hundreds of progressive manufacturers and skilled designers. Part of the business may drift later on into monopolistic hands ; but the moment it does the lively public interest will dwindle and the pace of improvement will decidedly slacken. The rate of electrical growth did not drop until grasping hands were extended to control whole sections of the industry, and we do not believe that there will again be rapid advances until the field has been occupied afresh by new concerns disdainful of the old methods and appliances.

A practical feature of the shows was the use of electric lighting. Madison Square Garden was a wonderful sight with its beautiful signs in large and small incandescent lamps by the thousand, many of them with commutating devices run by motor. We venture to suggest to the managers of the coming Electrical Exhibition that they require exhibitors to use electric signs wherever possible. The absence of view-obstructing booths was another element of beauty. The neat iron railings were also to be commended and imitated.

New York is evidently ready to patronize good shows of interest, and we are glad to know that the managers of the May Exhibition are meeting with excellent success in their endeavors to secure attractions of novelty, charm and instruction for the masses.

THE COST OF INCANDESCENT LIGHTING.

WHEN Mr. Edison projected the first incandescent light station it was his aim to produce the electric light at a cost not to exceed gas. That these early attempts did not meet with immediate realization are matters of historical record, but in spite of this fact incandescent light from the very beginning advanced in public esteem in virtue of its intrinsic merit, which consumers have all along recognized by their willingness to pay for. But with improvements in lamps and methods of distribution the cost of incandescent lighting has been steadily lowered until a point has been reached where large consumers can be supplied with profit to the central station, at a figure which puts the electric light in direct competition with gas on the basis of cost solely. As an example of this we need only refer to the rate prevailing in New York City, in which one large customer on the Edison circuits is supplied at .4 cent per lamp hour. These results have been accomplished with a 50-watt lamp and as it is evident that higher economy lamps must inevitably displace those in present use, just as these drove the old 64-watt lamp to the wall, it is eminently timely to inquire just what would be the effect of the introduction of a 37½-watt 16 C. P. lamp, that is, one of 20 lamps to the horse power, with a life equal to that of the one in use at present. Mr. Edison has addressed such an inquiry to Prof. W. D. Marks, whose answer we print in full elsewhere in this issue. Taking the Philadelphia Edison station, carrying 89,359 lamps attached, as a basis, Prof. Marks shows that other things being equal incandescent lighting could be furnished at .43 cent per lamp hour, equivalent to gas at 86 cents per 1,000 cub. ft., and produce 15 per cent. on the invested capital of $2,250,000. These figures are of a most interesting, not to say startling, nature and present an argument and offer an incentive for higher economy lamps which will not be lost. Already 150 and 200 volt lamps have been making gradual headway abroad and we think that in this direction, of high volt, high economy lamps, will be found the solution of the problem which will finally place the incandescent lamp beyond the field of competition with gas, if, indeed, it may not be deemed largely so already. There is nothing so effective in bringing home facts as a concrete example, and Mr. Edison and Prof. Marks deserve the thanks of the electrical community for bringing prominently into view not alone the objects to be striven for, but the profits awaiting the introduction of the 37½ watt lamp.

Apropos to the subject under discussion, we may refer to the description in another column of a high economy lamp in which a niobium filament is employed. It may be argued that the rarity of the metal employed and its seeming high cost of manufacture precluded such a lamp from practical consideration, but we may recall the fact that Mr. Edison spent years and a fortune in quest of the proper vegetable fibre used by him, and also that lamps once sold by him for $1 can now be had for 18 cents, and less.

TELEPHONE, TELEGRAPH AND CABLE.

THE vogue of the bicycle may be marvelous, but to us it seems that the popular use of the telephone is something even more remarkable. The ratio of calls to subscribers averages not less than 6 per day, on the other side of the water, while the average here, we believe, may safely be put, for most places, at 12 per day per subscriber. There is, it appears also, from recent statistics, a rapid increase in this country in the number of subscribers. Seven years ago, the ratio of telephones to population in cities numbering from 40,000 to 100,000 was about 1 to every 200. Now it is said to reach from 1 to 50 and 1 to 100, averaging 1 to 75. Moreover, this increase is likely to be more than maintained. The recent competition in many places has greatly stimulated the use of the telephone, and a factor for development in places like New York, where no competition exists, is the measured system, which enables everybody who really needs an exchange service to get it cheaply.

In this connection, while speaking of telephone growth and prosperity, it is worthy to note that the Sunset Telephone Co. is teaching its operators the art of telegraphy. This may or may not have some relation to the expiration of the American Bell-Western Union contract next November. Meantime, the Western Union Company owing to the steady reduction of its income is understood to have been reducing its force of operators in the larger cities, in some cases to as large an extent as 50 per cent. This diminution of income may also explain the non-issuance of the Company's statement of test office receipts. One item of income, however, ought to be much larger, and that is the one representing the revenues on the submarine cables, due to war scares and crazes. We begin to suspect the cable people and the ammunition vendors of working up a new call to arms whenever the old one peters out.

Telephony and Telegraphy.

THE "KR" LAW AS APPLIED TO QUADRUPLEX CIRCUITS.

BY

ATTEMPTS innumerable have been made in the past to improve the working of the quadruplex telegraph system, which as every experienced telegrapher knows is still far from being a perfect one especially when operated upon long lines. This is because there has not yet been found for its "No. 2 side" a simple receiving apparatus with a sufficiently low "time constant" or requisite degree of delicacy to respond promptly to the first impulses of the current waves which flow to line after each reversal of the sending battery.

The distance to which it is possible to operate successfully a quadruplex circuit with a given potential is, in reality, limited by the electro-static capacity (K) and the resistance (R) of the line: the former factor tending to absorb a portion of every current wave or impulse sent into it, while the latter affects the final strength of the current flowing through it.

The number of signals that can be transmitted per second over any telegraph circuit depends, in fact, upon the numerical value of its capacity in microfarads multiplied into its resistance in ohms, or upon what is known as the "KR Law," which has long been understood to determine the carrying capacities of all our long submarine cables, fast speed automatic circuits, etc., but the applicability of which to quadruplex working has not been so generally known or appreciated.

In telephony this particular law has played a very important part inasmuch as it has rendered possible the calculation of the size of wire required for the successful transmission of speech. It has determined, for instance, that

When KR = 15,000 speech becomes impossible;
" KR = 12,000 speech becomes possible;
" KR = 10,000 speech becomes good;
" KR = 7,500 speech becomes very good;
" KR = 5,000 speech becomes excellent;
" KR = 2,500 or under speech becomes perfect;

so that if a suitable value be adopted as the KR constant for any projected telephone line, it will only be necessary to select the proper kind and diameter of wire, the product of whose capacity in microfarads into its ohmic resistance will give the required standard.

It may here be remarked, however, that the accuracy of the KR law has been questioned with regard to its general application, instances having been cited in connection with the construction and operation of American telephone lines which apparently went to prove that the law is only safely applicable to circuits whose length is within the limits of those by which the rule was formulated. Mr. W. H. Preece who enunciated the formula has pointed out, however, that in the cases alluded to, the value of K was not accurately determined, since the purely metallic character of these circuits exercises a modifying influence upon their electrostatic capacities, or, in other words, reduces the values of K, a consideration that had apparently been lost sight of. Hence the deductions drawn from the measurements made and results obtained in practice (which were quite at variance with the rule laid down), were shown to be based upon false premises, inasmuch as a more correct estimate of their KR values accorded very well with the formula as well as with the telephonic effects observed.

Now since the KR conditions of a line have such an important bearing upon the working of telephone circuits, and as the law pertaining thereto is equally applicable to telegraph circuits, it would seem desirable in the latter connection, that for each of the important systems in use, a KR value should also be found that would serve as a standard for determining their working capacities and the distances through which these systems could be worked direct.

In the absence of any data bearing upon the subject, the following may be interesting as affording at least an approximate idea of the efficiency limitations imposed by the KR law as applied to quadruplex working in one particular instance.

Some time ago the writer was called upon to make a test over the Western Union lines, of the new 300-pound copper wire (868 miles in length) between New York and Chicago, for the purpose of ascertaining whether, in view of its low mileage resistance, it could not be operated as a quadruplex circuit direct, that is, without the aid of a repeater in circuit.

The test was made under highly favorable conditions, the weather being fine at all points along the line, while the inductive interference from neighboring wires was comparatively slight, owing to the particular day and hour of making the experiment. The type of instrument used on the "No. 2 side" was that known as the Freir self-polarizing relay, the potentials employed being 360 volts at Chicago and 320 volts at New York. The value of Chicago's current was 19 milliamperes from the "short" end; and 57 milliampres from the "long" end; the latter developing in the New York instrument an amount of magnetism considerably in excess of that ordinarily obtained in practice, inasmuch as the average full working current on a quadruplex circuit does not exceed 45 milliamperes.

Despite these favorable conditions, and notwithstanding the fact that the apparatus was adjusted to the highest degree of delicacy at both ends of the line, it was found impossible to secure satisfactory working signals on the No. 2 side when the distant polechanger was in operation. The effect of the "reversals" upon the second side relay, cut down its working margin to an extent never before observed in the writer's experience, a result which apparently demonstrated that the advantage gained by the new wire in respect of its low mileage resistance, was more than counterbalanced by the detrimental action, arising from its increased inductive capacity.

It would appear in fact from the distance involved and the amount of surface exposed, that the absorptive properties or condenser-like action of the conductor had increased in much greater ratio than the resistance of the wire had been decreased, and as a consequence the current waves became unduly retarded. This retardation was sufficient in amount to prevent the No. 2 relay—after each "interval of no current"—from becoming energized with that rapidity and intensity necessary to counteract the tendency of its retractile spring to open the armature and thereby mutilate the signals during the aforesaid "intervals," or periods when no magnetism is created in the receiving apparatus.

With a view to determine as closely as possible the KR conditions of the circuit, measurements were taken which showed that K = 13.4 microfarads, and R = 2,682 ohms, thus making KR = 35,938; a numerical value so much in excess of that of the regular successful quadruplex circuit as to clearly account for the difference in results obtained.

When the circuit was divided and repeatered at Pittsburg, there was no difficulty whatever in operating all four sides of the system, although in this case the full strength of Pittsburg's current did not amount to more than 41 milliamperes (16 units less than that received from Chicago), which current, however, afforded a margin amply sufficient to allow of a considerable range of adjustment on the No. 2 side without affecting the quality of the signals during the distant reversals.

The KR value of the circuit under these altered conditions was estimated at about 10,500, so that the following results may be said to have been fully established: (1) an excellent working quadruplex circuit when $KR =$ 10,500. (2) An impracticable working quadruplex circuit when $KR = 35{,}938$; and between these two values are of course to be found the good, bad, and indifferent grades, as well as the limiting figures representing the successful working quadruplex circuit.

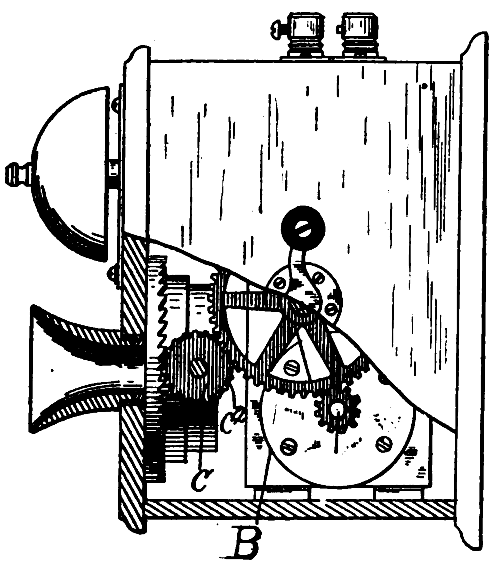
According to the KR law, the speed of a current wave through wires of the same length varies inversely as the product of the inductive capacity and the resistance of their conductors. In wires similar in all respects except length, the speed of a wave in each, is inversely proportional to the squares of their respective lengths, so that the carrying capacity of a wire of a given length, ought to be four times as great as that of a similar wire extending through twice the distance.

As a matter of fact the actual working capacity of a circuit divided in this way is not strictly in accordance with this rule, for reasons that need not be discussed here; but the application of the rule nevertheless affords a clear indication of the advantage of repeatering a long telegraph circuit, the KR value of which will only be that of its longest section.

From these and other considerations, the adaptability of the law to ordinary telegraphy will at once be apparent, and it may reasonably be inferred that the determination of the KR constants for aerial telegraph lines would prove as advantageous in this particular branch of electrical science as in those of telephony and cable working.

THE DINSMORE NON-PACKING GRANULAR CARBON TELEPHONE TRANSMITTER.

MANY devices have been applied to prevent the packing of the carbon in telephone transmitters, which interferes seriously with the efficiency of the apparatus. A novel method of obviating this difficulty is that adopted



DINSMORE'S NON-PACKING TELEPHONE TRANSMITTER.

by Mr. S. A. Dinsmore, of Chicago, whose arrangement is shown in the accompanying engravings.

As will be noticed the receptacle holding the carbon is provided with a toothed rim, which gears with a wheel driven by the handle that operates the magneto-call. Thus it is evident that when a call is sent to the exchange the transmitter capsule is rapidly revolved and the carbon shaken up and redistributed. In this way permanent packing is avoided.

RUN DOWN BY TELEPHONE IN THE BURDEN DIAMOND ROBBERY CASE.[1]

ONE of the cleverest bits of rapid transit detective work ever done in New York City was performed on Saturday, Jan. 4, by Detective Sergeant Evanhoe of the Central Office, Mr. I. Townsend Burden, Manager Schultz of the Thirty-eighth street office of the Metropolitan Telephone Company, and half a dozen others, including telephone operators, shop keepers, and policemen. The funniest part of it all is that the operators, shop keepers, and policemen hadn't the faintest idea that they were assisting in the detection of a man supposed to be the possessor of all or a part of the $65,000 worth of diamonds recently stolen from Mr. Burden's house in Madison square. Most of them didn't even know why they were doing what they did, and they wouldn't know to-day except for this story.

The telephone played the principal part in the arrest that was made, and the wires did their duty well, for by means of them a man at a telephone in Fulton street, was first identified by a man who hadn't the faintest idea why he was identifying him, and then arrested by a policeman from the Old slip station, who was equally ignorant why he was arresting him. And it was all done, too, in less than four minutes, under orders from another man, who sat at a telephone in the Holland House at Fifth avenue and Thirtieth street, and directed the entire affair.

Mr. Burden, who had been getting on an average a dozen letters a day since he advertised a reward for the return of his diamonds, got among other similar missives, a typewritten letter, which sounded so plausible that he resolved to pay some attention to it. It was written on Irish linen paper, and the top, probably a business letter head, had been torn off. The letter was simply addressed to Mr. Burden, and the writer said that he had observed Mr. Burden's advertisement for the return of his jewels, but had refrained from writing before because he could not consent to have any dealings regarding the stolen property unless the $5 000 reward was raised to $10,000. He knew exactly where the jewels were, he said, and was the representative of the men who had them, and who would return them for $10,000. The letter, which was well put together, wound up as follows:

> Of course a man in my position cannot agree to meet you or to see you anywhere. I do not hesitate to say that I do not trust you, and I want you to understand that this is positively the only letter I shall write to you. However, I have a scheme by which we can communicate with one another, and I hereby lay it before you for your consideration. Advertise in the personal column of any New York paper at any time during the next few days a telephone number where I can ring you up, mentioning the time and date when you care to hear from me.

There was no signature to the letter, but it sounded so well that Mr. Burden summoned Detective Evanhoe, who has been working on the case from the beginning. The more the two thought about the matter the more convinced they became that this latest correspondent was serious in his offer and really knew something about the whereabouts of the stolen jewels. Detective Evanhoe wanted to fix up a scheme to arrest the man, but Mr. Burden hesitated. He finally agreed, however, to let Evanhoe do his best to get at the mysterious correspondent. It was understood, that if there was anything to connect the man with the robbery of the Burden mansion Evanhoe was to lock up the man.

This was the state of affairs when Mr. Evanhoe began racking his brain for some scheme by which to catch the man. As a preliminary this advertisement was published:

> $10,000 reward for recovery of the property taken from 5 East 26th St. on the night of Friday, Dec. 27, and a liberal reward will be paid for information leading to the recovery of the property. Parties can communicate in confidence with the owner and no questions asked.

Evanhoe went down to the headquarters of the Metropolitan Telephone Company, at 18 Cortlandt street, explained matters to the telephone people, and asked them to help him out. The telephone people hesitated for a time. It wasn't their business to do detective work, they said, although they were ready to admit that the language of a recent law required them constructively to assist, if necessary, in the work of justice, when called on. Besides while it is an easy matter to trace a line ahead to any point in the system, it might take hours to trace one back after the plugs had all been pulled out, and might necessitate the ringing up of hundreds of operators. The telephone people explained all this, but Evanhoe pleaded that it was the only chance he had to get his man, and finally enlisted them on his side. The telephone people undertook to do their best, and it was finally agreed that Mr. Burden should insert an advertisement in a Saturday morning paper, telling his correspondent to ring up telephone 1,765, Thirty-eighth street, which is one of the Holland House telephones, at precisely 8 o'clock. There is another telephone at the Holland House, not two feet away from the first one, and by means of this latter telephone it was hoped to trace the man who would be talking to Mr. Burden. Manager Schultz of the

1. Abstract from the *New York Sun*. The story told in that paper is here given substantially but has been revised with the assistance of the Metropolitan Telephone Co., in order to make it correct technically, certain parts of exchange and trunk line operation not having been familiar to the clever reporter who prepared the narrative.

Thirty-eighth street central telephone office was let into the secret and advised as to the part which he was to play in the execution of the plan. Mr. Burden went to a newspaper office, where he inserted the following advertisement, which appeared on Saturday morning:

CALL up telephone number seventeen sixty-five 1765 38th St., Saturday, afternoon Jan. 4, at 3 o'clock sharp.

At 2½ o'clock Saturday afternoon Detective Evanhoe and Mr. Burden met at the Holland House, where the telephones were held open for them. A few moments before 3 o'clock Mr. Burden entered one closet and the detective the other, and then all waited anxiously for the tinkle of the bell which would indicate that the man with the secret of the whereabouts of the Burden diamonds had seen Mr. Burden's advertisement. Just as the big clock in the hall of the hotel was at its third stroke the bell in Mr. Burden's closet buzzed. He clapped the receiver to his ear, and a second later was conversing with the man who had sent him the letter.

By previous arrangement, Manager Schultz, at the Thirty-eighth street exchange, was on the qui vive, and by a signal from Detective Evanhoe learned that Mr. Burden was talking with the man whom it was desired to locate. Schultz inquired at once of his operators, in the usual "monitor" way: "Who has 1765?" and "What trunk?" The answer was "42 Cortlandt." Schultz cut through to Cortlandt and inquired who was talking on that particular trunk. He was told "2840"—Cortlandt, of course.

It only took about four seconds for Schultz, running his eye up his numerical record, to see that telephone 2840 Cortlandt was in the store of Lewisohn Brothers, dealers in metals at 81 Fulton street.

He at once gave Evanhoe the location and immediately connected him with Police Headquarters ("30 Spring") who through their private telephone system (which connects all precincts direct with Headquarters) communicated with the Old Slip Precinct; so that the moment the mysterious caller was located policemen were detached to arrest him.

While Evanhoe was talking to Headquarters and Burden was holding the man at the telephone, Schultz made a hasty examination of his "geographical list" and found that there was a pay station at 74 Fulton Street, number 3629 Cortlandt, in a cigar store kept by J. H. Fahrenholz. This station he called up and requested Fahrenholz as a favor to go over at once and see who was using the Lewisjohn telephone and identify him if possible. This Fahrenholz hastened to do while Schultz held the wire. Fahrenholz crossed the street, took a look at the man, returned to the telephone and reported to Schultz in but little more time than it takes to tell it. Schultz was gratified at the successful working of his by-play and reported in turn to Evanhoe.

The man at Lewisohn's telephone was now getting uneasy and when Mr. Burden could hold him no longer, he and Evanhoe flung themselves in a cab and hastened down town. In twenty minutes they were in Fulton street and pulling up in front of 81. Evanhoe jumped from the cab before it stopped and ran inside to find a pale-faced young man secure in the custody of two bluecoats. Gathered about were the Messrs. Lewisohn and a half dozen clerks. They were remonstrating with the policemen, who couldn't explain what they were holding on to the young man for, but who nevertheless refused to let him go.

"Did you get him at the 'phone?" asked Evanhoe.

"I did that, sir," replied one of the policemen.

In a few words Evanhoe explained things to Mr. Lewisohn, and then he learned that the young man was a clerk in the store. He was taken into Mr. Lewisohn's office, where he at first denied that he had ever had Mr. Burden on the telephone, or had ever spoken to him at all. When confronted with the fact that he was caught at the telephone, he admitted that he might have been talking to Mr. Burden or almost anybody. He had seen the personal notice in the paper, he said, and had rung up the number as directed, because he had a cousin living in the West who had once said to him that when he came to New York he would advertise a telephone number for him to ring up. The young man was very much excited throughout the interview, and denied that he had ever written a letter to Mr. Burden. The paper in the office, however, was found to correspond exactly with that on which Mr. Burden's letter was written and the typewriter print agreed in the same fashion. But threats and pleadings failed alike to make him confess.

He wouldn't explain his presence at the telephone in any other way than as above. There was a consultation between Mr. Burden and Detective Evanhoe as to whether the young man should be arrested and it was finally decided not to take him in custody. The Lewisohns were also asked not to discharge him, and the man at last reports was still working in the Fulton street store.

Detective Evanhoe was pleased over the successful working of his scheme, but not quite satisfied with the final result. He thought that he surely had the Burden burglar, or at least a man who was connected with the crime and could be forced to give information which would lead to the capture of the right man. He isn't by any means sure yet that he hasn't got a clue.

THE PROPOSED SUBMARINE CABLE CODE.[1]

THE decision that after January 1, 1898, the European government telegraph companies will refuse to receive any messages not made up of words contained in the vocabulary of 250,000 words published by them in 1894, and the strong probability that the American companies will adopt the same rule, have been the causes of a good deal of opposition among merchants, opposition which is likely to continue until the question is finally disposed of one way or the other. Especially, perhaps, in America, where the question has thus far been less fought, will there be a hard conflict between the companies, possibly aided by some of the merchants on the one hand, and on the other many business firms which think their interests will be seriously hurt by the innovation.

In New York the attitude of a considerable body of merchants has already been expressed. The New York *Journal of Commerce*, for instance, last April published a long editorial attacking the system. Beginning with an admission that the innovation was probably needed, and that the avowed purposes with which it has been started—to lessen disputes, decrease error, and prevent dishonesty—are good ones, that journal contended that the new vocabulary increases rather than decreases the dangers and difficulties of code transmission. It then called for official action by the various exchanges, demanding a thorough revision of the code, and for individual protest as well, to be made promptly, since such a revision will need a long time.

The objections which were made in this article, as well as those which have been made in other protests to be mentioned later, are essentially the same as those brought forward in a communication which the *Evening Post* has just received from a member of the China and Japan Trading Company of John Street, in which the writer says:

"The objections raised against the compulsory use of this vocabulary are upon two grounds. Under previous regulations of the conference codes were permitted made of words, having not more than ten letters, taken from eight designated languages. Subject to this, codes have been built up at the expenditure of enormous labor and great cost, many of them containing 300,000 to 400,000 words. To wipe these out, and compel the use of a much smaller number of words with which it is impossible to make an adequate commercial code, is an act of injustice and oppression.

"The 'official' vocabulary is full of glaring faults which threaten endless confusion and inconvenience in actual use. The compilers of the vocabulary were evidently without experience, and their work has been aptly described as an elaborate blunder from beginning to end. In their preface they state that they 'took care to be entirely independent of preëxisting works of the same kind,' which is to say that they deliberately disregarded all previous experience, that the excellent codes which had been published and which merchants had compiled were all to be set aside as things of no value, and that there is to be put in compulsory use a code which neither in extent nor in quality can meet the requirements of business. In this vocabulary, in which all the words ought to differ from one another 'by at least two letters, and by three elementary Morse signals' (I use the words of the preface itself), are to be found innumerable errors and inadmissible words, such as:

Words identical in signals with other words.
Words with only one signal difference from others.
Words with only one letter difference from others.
Words differing from others by prefix only.
Words with first letter signals dangerously like others.
Words representing names of articles of commerce.
Words representing days of week and names of months.
Words representing coins and measures.
Words representing numerals.
Words representing names of places and districts.
Words representing names of firms.

"The consequences to merchants of being compelled to use this vocabulary will be so serious that action is being taken by commercial bodies in all parts of the world, and great pressure will be brought to bear upon the coming conference to have the action of the last revoked, or very considerably modified."

So important is this matter thought to be in England that in November one of several communications on the subject printed in the London *Times* filled over two columns. This was from the Secretary of the London Chamber of Commerce, who says, "We know that the British commercial world, which forms the immense majority of code users all over the globe, is strenuously opposed to the idea of such a vocabulary. * * * On the sound principle that they who use a commodity are the best judges of their requirements in regard to that commodity, we think that their views as to what they do and what they do not require in the matter of code words should prevail." The Secretary then goes into detail about the vocabulary to prove that the compilers were careless and inexperienced and the official vocabulary unsafe and dangerous. "The main issue, however," he proceeds, "is

1. *Evening Post, N. Y.*

this: after various restrictions and alterations from 1869 to 1879, the present rules were settled in the latter year. They have now been in force for sixteen years; all existing telegraphic arrangements have been founded upon them; and the commercial community rightly claim the prescriptive right to their full benefit."

The London Chamber of Commerce took action along these lines, and a number of reprints from their publications have been during the fall circulated among merchants. The Chamber has also appealed to the Postmaster-General to take action, and has sent requests to Chambers of Commerce in other cities to take a similar course. Some of the foreign and British Chambers of Commerce have concurred in the action of the London Chamber of Commerce. As the matter now rests in England, the government has given an assurance that it is aware of the inadequacy of the code and will carefully consider the advisability of sending a formal protest to the conference of next fall at Budapest, when the matter will be finally settled. Just what steps will be taken in New York cannot yet be foretold. Among the protests already made is one by the New York Coffee Exchange, directing its Superintendent to present the objections to the new vocabulary to the New York managers of the several transatlantic cable companies.

ELECTRIC TRANSPORTATION.

THE AIR-CHAMBER TROLLEY CONDUIT IN VIENNA.

IT has been remarked many times that what are really American inventions have to be introduced into this country from Europe, and another instance of this is now presented. After several attempts and nearly as many failures, our street-railways are now just introducing underground trolley systems, years after Europe had at least two in use,—Blackpool and Budapest. These systems are costly, at least $45,000 per track mile when complete with feeders, etc., owing to their great depth below the surface of the street and the nature of the materials used in their construction. With the slotted conduit with bare conductors, as in the Lenox avenue here, the Metropolitan (9th St.) line in Washington, and other systems, it is not possible to reduce this cost to any material extent.

About August, 1894, an experimental conduit was laid in Germany, near Berlin, which departed radically from the Budapest, Lenox avenue, and like systems,—which rely on the great size of the conduit to keep water, snow and ice away from the wires,—and brought down the size of the conduit to 7″ x 5″,—outside measurement. These trials were completely successful.

The nature of the new conduit is indicated by its name "air-chamber trolley conduit," and it consists of a slotted conduit made up of sections, the top being formed like an inverted box, with the object of preventing any water in the conduit from extending into this box by virtue of the air in it; the conduit and even the street may therefore be immersed in water, but the air confined in this box keeps the water from reaching the wire which is supported therein.

We noted lately the fact that several lines in Vienna were to be equipped electrically. The bidders were Herr E. Lachmann, who carried through the test of the air-chamber trolley conduit described above. Other bidders were: Adolph Springer, Vienna; Kontinentale Gesellschaft für Elektrische Unternehmungen, Nürnberg; Allgemeine Elektricitäts-Gesellschaft, Berlin; Wiener Bankverien, Vienna; Neue Wiener Tramway Gesellschaft with the Anglobank and Siemens & Halske, Vienna; Bau-Unternehmung Ritschel & Comp., Vienna, with the Union Elektricitäts-Gesellschaft, Berlin; Stadler Stephan, Vienna.

We are informed that Mr. Lachmann was successful in the bidding and that a contract to equip a line with the air-chamber trolley conduit system was awarded him, the line to be finished by April next. If this is satisfactory to the authorities, he will equip all the other lines likewise. The fact that Mr. Lachmann was victorious over such great competitors as those named speaks volumes for the system adopted.

The introduction of the air-chamber trolley conduit it is expected will lead to its introduction here, for it is claimed to be very much cheaper to construct than any of the other systems named above, and works just as well when immersed in water as at any other time. The system, which is the invention of Mr. R. W. Barkley, of New York, was illustrated in our issue of July 6, 1892.

THE MASSACHUSETTS RAILROAD COMMISSIONERS ON ELECTRICITY.

THE railroad commissioners in their annual report to the legislature discuss at great length the use of electric motive power. They consider it in many respects an unsolved problem. The competition of street railroads is reported to be severe.

Experiments on steam railroads thus far tend to show that a sufficient quantum of power can be obtained through the medium of electricity; and, thus far, they have proved nothing else. The question of economy, even in these cases, is still unsolved.

The board even considers that the case of horse vs. trolley on street railroads is unsettled as to economy.

The most efficient and economical use of electric power will be found where there is a considerable and steady volume of local and short-distance travel, which requires or justifies the running of numerous light passenger trains, at short and regular intervals, so that the trains will be constantly and uniformly distributed over the railroad line.

It is admitted that electricity is not suited to the moving of freight traffic, and it is not claimed that it is economically adapted to the moving of long-distance passenger traffic. Its province in railroad operation must, therefore, be, if anywhere, in moving suburban passenger traffic, or short-distance interurban and local passenger traffic, or the isolated traffic of branch and spur lines.

On a branch or spur line, where the present traffic, while not large enough to make steam power profitable, is not too small to be developed into a paying business by a service conducted substantially on the street railway plan of operation, it may be advisable to substitute electric for steam power; on the main lines it is not yet prudent.

Inter-town lines necessarily parallel the railroad lines, and thus become competing lines, not only for suburban, but for inter-urban and inter-town travel; and this competition is more or less sensibly or seriously felt by the railroad companies on various sections of their roads.

The railroads have a right, by any legitimate means, to secure their present traffic and to recover the traffic they have lost. The remedy proposed, a clearly legitimate one, is the electrical equipment of their lines for suburban and other local service.

In point of frequency of service, it is in the power of the railroad to put itself on a par with the electric line, with or without a change of motive power.

As regards the rate of fare, it is true that the railroad might with the introduction of electric power, as it can now, reduce its fares to a level with those on the street car. It is equally certain that it could not then, any more than now, other conditions remaining the same, afford to do so.

However cheap electric power may turn out to be, it will, to say the least, be no cheaper for the railroad than for the street railway. The railroad, moreover, is loaded at the start with a burden of investment from which the railway is wholly free.

The remark sometimes heard that street railway dividends are paid by the passengers who ride on the platforms and steps, is probably an exaggeration. It would be nearer the truth to say that they are paid by the passengers who ride standing up. The railroad could not earn its dividends in this way.

While the introduction of a more frequent service on the railroad would no doubt create returning eddies along the margin of the great stream of short distance travel as it now flows, there is much reason to question whether, so long as the other conditions which have been noted continue to exist, that alone would be sufficient to turn the main current from its present course.

Whatever the diversion of short distance travel, the increase of population and industry which the electric railway will foster and develop along the railroad lines, will still be tributary to the latter in a hundred ways.

BROOKLYN RAPID TRANSIT CO.

The Brooklyn Rapid Transit Company has filed articles of incorporation with the Secretary of State. Its capital is $20,000,000 and it paid as a preliminary state tax, $25,000. The purpose of the company is to "construct, extend, repair, and improve railroads," and furnish motive power. The directors are W. C. Bryant, Horace C. Duval, W. W. Goodrich, John D. Kieley, Timothy S. Williams, and C. L. Rossiter of Brooklyn, E. L. Button, W. F. Creed, Frederick S. Flower, Otto Zarker, Jr., Thomas Renwick, Floyd Vail, and James N. Wallace of New York city. Each director takes one share of stock, the company thus beginning business with $1,300.

MISCELLANEOUS.

CONCENTRIC WIRING.[1]—III.

BY SAM. MAVOR.

(*Concluded.*)

SWITCHES have been greatly improved during the last few years, both in mechanical design and in external form. The clumsy switches, with the ugliness of their porcelain covers embellished by gilt lines or floral decorations, have now nearly disappeared. They are superseded by switches of neat appearance, with suitable metal covers. The working parts of the switches are of a much more mechanical type than formerly, butt here still remains ample room for improvement. There are far too many parts, too many screws, and too many contacts. The practice of dispensing with binding screws and soldering the wires directly to the contact plates should be highly commended. How often one sees the attempt made to secure the ends of conductors —frequently of considerable size—under paltry little cheese- or round-headed screws and washers absurdly too light and inadequate to the purpose! The ceiling rose is also a weak spot in double wiring. There are far too many contacts in it. To begin with, there is the usual crockery base, and upon this base are three little brass plates, with twice that number of brass screws. Each of these six little screws binds to a contact the end of a conductor or fuse, and every screw of them is liable to become loose, and every contact to become oxidized. Where vibration or moisture are present the development of trouble is only a question of time. Do those who so freely erect these little collections of screws and contacts ever consider the harvest of petty troubles and annoyances which will be reaped by-and-by?

We must now pursue our painful path of adverse criticism to the lamp holder. The double-contact lampholder, especially when attached to flexible pendants, is the frequent seat of short-circuit and minor troubles. In this little piece of apparatus there are two contact plates, carrying the buffer springs and the inevitable binding screws. Each of these contact plates must be insulated from the other, and both from the surrounding metal tube. When this is done small space remains for further intrusion. But the flexible conductors are still to be brought in and pinched under the binding screws. Stray strands from these flexibles, where they are not most carefully soldered, are frequently responsible for short-circuits and the melting of many fuses. The risk would be reduced if here also binding screws were dispensed with and the wires brought straight through the insulating disc into holes in the plates and soldered therein.

It is with a sense of relief that one turns from double wiring and all its attendant ills to the simple mechanical and straightforward methods of concentric wiring with an uninsulated outer conductor. So far as the writer is aware, no system of concentric wiring in which both the inner and outer conductors are insulated has ever been used for indoor work. It appears probable that the difficulties in the way of designing junctions, switches, and other accessories which shall meet the electrical and mechanical requirements within moderate dimensions and at reasonable cost, will prevent the introduction of such a system. Two and three-wire concentric cables with each conductor insulated are largely used as mains in connection with two and three-wire systems, but in such cases there is no difficulty in providing junction boxes of adequate size. The only system of concentric wiring which has been adopted for internal use has an uninsulated outer conductor, and it is this system that is known as "Concentric Wiring." It is important that it be clearly understood that concentric wiring is not "single wiring," but is something essentially different. This distinction between concentric wiring and single wiring is necessary, because the two have been frequently confused. No method of wiring merits the title "concentric" which is not consistently concentric throughout. In a concentric system the central conductor must be everywhere surrounded over its insulation by a metallic sheathing of conductivity equal to or greater than the core. The switches and fuses should be in the central wire and enclosed in metal cases. These cases or boxes should be electrically and mechanically jointed to the outer conductor, and so form part of the continuous metallic envelope in which the central conductor is enclosed.

It must be pointed out here that, under the existing Board of Trade regulations referring to the insulation of electric light supply mains, concentric wiring is not admissible where connection has to be made to a source of public supply in this country. This is a matter to which we shall recur, and shall meanwhile consider the question of concentric wiring with regard to installations supplied with current from independent plants. The adoption of concentric wiring is the royal road out of the difficulties and dangers which beset double wiring. It seems to be difficult for those who have been accustomed to devote so much pains to attain good insulation of both conductors to realize that there is no necessity for doing so. The adoption of concentric wiring dispenses with this necessity, and abolishes risks which make a high standard of insulation of both conductors in a two-wire system so desirable. Much misunderstanding and prejudice, due to lack of information, exist with regard to concentric wiring; but there is complete absence of valid objections to its use, and prejudice against it is soon dissolved by an acquaintance with the system.

Some of the fire insurance companies were at one time rather suspicious of concentric wiring, probably because they feared its adoption would lead to the abolishing of their cherished rules regarding the width of fillets in wood casing, etc. The insurance companies are, however, now unanimous in their favorable verdict on the subject, and have recognized the advantages of concentric wiring from their point of view. More extended experience and appreciation of its fireproof qualities must confirm the preference many of them now have for concentric wiring.

It has been stated that, owing to one conductor being already earthed, the liability to complete breakdown of the insulation is doubled. This might be true of double wiring, but is certainly not true of concentric. The outer conductor being already at earth potential, there cannot be any risk whatever of shock or spark being experienced from it. There is thus only one vulnerable conductor, and this, with its insulation, being encased throughout its entire length in the metallic sheathing formed by the outer conductor, is well protected against injury. The consequences of injury to concentric and to double wiring are essentially different. In the case of the concentric conductor, if it should be crushed or a nail be driven into it, the instantaneous result is a dead short-circuit and the melting of the fuse. If the insulation should be punctured and moisture gain access, the distance across the insulation between the conductors is so small that the fault immediately develops into a short circuit, and the spark passes from the centre conductor to the inner surface of the metallic sheathing, and being entirely within the sheathing it cannot communicate fire to its surroundings. Concentric conductors are thus self-testing. Faults cannot endure. They cut themselves out automatically. Or, rather, this is what they would do if faults were experienced: but we never have faults in lead-covered concentric conductors. How different is the case of ordinary double-wire conductors laid in the separate grooves of a wood casing! The casing which is provided for mechanical protection may become a positive source of danger, and may be ignited by leakage across the fillet—a danger which the fuse is powerless to prevent. In concentric wiring there is only one cable to handle instead of two, and this carrying its own protection the necessity for wood casing is abolished.

Perhaps the most conspicuous advantage of concentric wiring is that it may be so easily and so effectually made waterproof. The cables may be enclosed in lead sheathing laid under or over the outer conductor, and hermetically sealed to the various apparatus into which the cables are led. This must appeal to all those who have had a varied experience of wiring. If moisture—the arch enemy of good insulation—can be permanently excluded, it means the permanent maintenance of a high standard of insulation, and consequent freedom from trouble.

The next important advantage to be claimed is the large reduction in the number of fuses. The drastic method of abolishing fuses is to maintain the section of the conductors. This can readily be done in concentric wiring to an extent impracticable in double wiring. Conductors of much larger section may be conveniently and safely led into C. C. lampholders, ceiling roses, and wall sockets, than is possible in double wiring. And thus, by maintaining the section of conductors right into the lamp holders, many of the objectionable fuses are abolished. The fuses when reduced in number are more easily centralized and arranged in groups of standard size. It may be objected that if the number of fuses is diminished a larger number of lamps are affected in the event of a fuse being melted by a short-circuit. This is a very natural objection for one experienced in double wiring to offer. But it has no application to concentric wiring. We never have short-circuits. It is in double-contact lamp holders, and double-wire flexibles, ceiling roses, and the like, that short-circuits occur. Compare a central contact and a double contact lamp holder. A $\frac{7}{18}$ concentric cable may be led into the former more easily, and with greater safety, than two single No. 16 L.S.G. wires or their equivalent can be led into the latter. It is not necessary to lead $\frac{7}{18}$ cables into concentric lamp holders, but the possibility suggests the large margin of safety in favor of the C.C. holders. The difficulty of avoiding mishaps in double-wire lamp holders will be emphasized by the introduction of 200-volt lamps. While on the subject of lamp holders, it may be noted that, there being only one buffer spring in the C.C. lamp holder, and that exactly in the centre, there is less risk of twisting lamps out of their collars while inserting or removing them. Concentric lamp holders, ceiling roses, and such fittings, having only one—and that a central—contact to be insulated, may be made of better mechanical design than where within the same space two contacts have to be insulated, each from the other, and both from the containing case. The benefit of the great reduction in the number of parts can hardly be exaggerated, the liability to derangement is so very greatly reduced.

In regard to fittings, the comparison is again in favor of concentric wiring. The flexible conductors of which the pendants are made are of such large section that they are mechanically strong. The pendant terminates at either end in a screwed brass nipple with insulating plug and central contact—an arrangement which is substantial without being clumsy. No loose strands are

possible. The top nipple of the pendant is screwed into the junction or fitting base, and the nipple at the lower end is screwed into the lamp holder. The brackets are similarly wired to screwed nipples with central contacts. The erection of fittings is therefore an extremely simple operation, and the labor so employed is reduced to a minimum.

The method of concentric wiring is based upon a full recognition of the fact that electric light wiring, in order to be permanently durable and reliable, must be impervious to moisture. So far as the writer is aware, this is the only method of wiring which provides a continuously waterproof metallic sheathing over the insulation from the main switchboard to the lamp holders. The main switchboard has the usual single-pole switch and fuse arrangement, and the board is surrounded by the negative omnibus bar, which receives in sockets attached to it the outer conductors and sheathings of the concentric cables. The main cables—which are lead-sheathed throughout, and are generally armored with galvanized iron wires laid over the lead on a cushion of jute—are carried without break or joint direct to their respective distributing boxes, where the central conductors are soldered to the omnibus bars, and the outer conductors terminate in gun metal sockets secured to the boxes. The distributing boxes are of cast iron or cast brass, enamelled white inside, and fitted with fuses, or switches and fuses, as required. These boxes have close backs and hinged fronts closing upon an india-rubber ring, thus rendering them proof against dust or moisture. The concentric branch cables which radiate from these boxes are under all ordinary circumstances of uniform section, namely, 7/21½—equal in area to 0.005 sq. in. The outer conductor of the cable has the same section of copper as the core, and the whole is enclosed in a solid drawn tube of lead. Wherever a joint is to be made, or the cable led into a switch or fitting base, the centre wire is soldered to its contacts, and the outer conductor and its lead sheathing are received and terminate in a jointing pocket cast upon the switchbox or junction. The central wire and its insulation are thus enclosed throughout their length in a hermetically sealed metallic sheathing. The section of the branch conductor 0 005 sq. in. is carried into every switch and into every lamp-holder, no reduction being made. There is no necessity for any fuses other than those in the cast-iron fuse boxes, and these are all uniform and interchangeable. It is very rarely that occasion requires any departure from this plan. Many large installations have been carried out on the lines indicated, some of these amounting to several thousands of lamps, where only two sizes of fuses—main and branch, respectively uniform and interchangeable—have been used. The simplicity and reliability of such a system must be too obvious for emphasis.

The branch cables are led through buildings like flexible gas pipes, but they are not liable to damage as composition gas pipes are. The conductors and the insulation within the lead sheathing serve as a backing for the lead, so that it is not at all easily damaged. It has been the custom of the writer's firm for years to have their concentric conductors and joints embedded in the plaster of new buildings, and they have never known a single instance of a fault developing in conductors so treated. It is sometimes objected that where the conductors are so buried they are not accessible. They certainly are not. Why should they be? It is essential that wood casings carrying ordinary double wiring should be accessible; further, it is desirable that they should be visible wherever possible. But the conditions with regard to lead-covered concentric conductors are entirely different. Given a conductor and joint of imperishable materials, and impervious to moisture and the acids found in plaster and cement, and no reason remains for laying conductors on the surface, or for providing access to them where enclosed in plaster. This demand for accessibility, and the objection to cover conductors with plaster, is a relic of the times when india-rubber-covered conductors laid in wood casing were embedded in walls. The bitter experience which rapidly follows this practice results in the prejudice against covering any conductors with plaster. If anyone wishes to have his conductors laid on the surface of plastered walls, by all means let him do so, but there is no necessity either to lay them on the surface or to provide access to them where lead-covered concentric conductors are used. Access to the distributing boxes only is necessary.

Another bogey is the chance nail driven into the plaster. Consider how largely the practice of embedding composition gas pipes in plaster is in vogue, and how immeasurably greater is the danger resulting from the piercing of such a pipe than from piercing the insulation of a conductor. Yet how seldom one hears any objection to the practice! If a nail is driven into a concentric conductor the immediate result is an emphatic short-circuit, and the fuse melts; there is not the slightest danger. Two cases only of nails piercing embedded conductors have come under the writer's notice. Both of these were in the same building—a block wired for about 500 lights, where all the conductors were embedded in plaster. The faults—one behind a picture moulding, and the other behind a dado—were readily localized, and repaired before the work was completed.

The insulation resistance of the wiring in a new building is not a matter which causes any anxiety. The lead sheathings and brass junctions and switch boxes make one independent in this regard. In occupied buildings the lead-covered branch conductors may be led about under floors and behind plaster and linings with the greatest freedom and complete immunity from danger. The amount of lifting of flooring and disturbance to woodwork and plaster is only a fraction of that required for the carrying out of wood-cased double wiring. The junctions employed may be manipulated by any intelligent man who can use a soldering bolt. No careful lapping of insulating material around the joint is required. The insulation is air space, and there is none better. The branch conductors are of uniform size—so are the junctions—and men soon become expert in jointing. The operation is so very simple and easily performed that it may safely be done by unskilled labor. This feature specially adapts the system for export. As an illustration, it may be stated that a squad of Hindoos, chiefly tinsmiths, under the guidance of one European, carried out in the most satisfactory style the wiring for 3,000 lamps in 10 weeks. In mills or factories floored with wood the conductors are cleated to the woodwork with brass cleats; and where iron beams and concrete floors are met, the conductors, with junctions (tapped to receive the pendants) attached at the proper intervals, are secured by brass or copper cleats to stranded steel suspending wires strained between eye-bolts attached to the walls. The laborious plugging of the concrete ceilings, with the resulting dust and disturbance to the work of the factory and expense to the wiring contractor, is entirely abolished. In single story weaving sheds, ironworks, or other buildings with iron roofs divided into bays, the same method of suspending the conductors between the beams or tie-rods is adopted.

In support of the claim that this method of wiring is reliably waterproof, the case of Messrs. Nobel's Explosives Company's West Quarter Factory may be cited. The buildings to be lighted are isolated and scattered over a large area in order to reduce the risk and minimize the effect of explosions. The regulations issued by the Home Office regarding electric lighting were so very stringent that it was impracticable to comply with them except by the use of concentric wiring. With concentric wiring everything was made easy. Its waterproof and fireproof properties overcame all the difficulties. Every joint and every yard of the conductors is outside and exposed to the weather, cleated for the most part to the gangways. The switches, of cast brass, and distributing boxes, of cast iron, are also all outside, protected only by watersheds. The work of wiring was completed more than three years ago, and, notwithstanding three years' exposure to the elements in this climate, the insulation resistance is as high as ever. Monthly tests of the insulation are required by the Home Office, and on the 10th of last month the insulation resistance was two and a half times higher than the most stringent of the fire office rules require for *indoor* wiring. In the nitrating department of the same factory, which is a quarter of a mile distant from the other installation, the insulation is equally satisfactory, although the wiring is subjected to the profuse fumes of nitric acid. It is noteworthy that the insulation of the wiring at both these places is not india-rubber, but is fibrous. The exclusion of moisture is therefore solely due to the lead sheathing and waterproof nature of the joints.

The more difficult the wiring of a building appears to be, the more favorable is the comparison to concentric wiring. The iron roofs, concrete floors, moisture, and other ills that vex the spirit of the double wirer, have no terrors for his concentric friend. For wiring in any situation, from collieries to boudoirs, where difficulties of erection have to be faced, or in situations where the conductors, &c., after erection must endure excessive heat or cold, moisture, acid vapor, or inflammable dust, concentric wiring meets the case. Conviction of its immense superiority is immediately impressed by inspection of buildings so wired. The thing requires to be seen to be appreciated. Concentric wiring has this further advantage—that a very simple and easily followed set of rules can be framed which are applicable to wiring to be carried out under widely differing conditions.

Contractors who are unacquainted with concentric wiring are often ready, when they know it is in competition with their double-wire tenders, to pour into the ears of their prospective client a dismal tale of the woes which would follow the adoption of any system which would not embrace their precious wood casing and crockery ware. If those contractors were informed on the subject, they would learn how great is their error. Take a contractor who has had experience of concentric wiring into any building whatever, and he will show how to make a better, more mechanical, reliable, and durable job, and generally at less cost, than is possible with double wiring. Those who have used only double wiring, and know no other, are reluctant, and with reason, to depart from practice in which their patterns are systematized and standardized, and in which their staff are trained. But when the change proposed is all in the direction of simplicity and reduction of labor the chief objections to its adoption are removed. That fires or minor troubles are not more frequent in badly-wired buildings is a fine testimonial to the safety of electric light wiring, but is no excuse for the continuance of slipshod work or adherence to existing methods where improvements are possible.

For mining work concentric wiring is specially adapted. The mechanical nature of the fittings, and the ease with which they and the conductors may be made waterproof, are important features. A

concentric cable for mining purposes is more safe than two separate cables. A fall of material from the roof may rupture one of two conductors, and if current is passing the inevitable result is a spark at the point of parting. In fiery mines this might have serious consequences. With a concentric conductor, however, the fall would crush the outer conductor in upon the core, and so cause a dead short-circuit and melt the fuse before the cable parted. The spark would thus take place at the fuse at the pit bank. In the only case of such accident within the writer's experience the fuse promptly melted. Several devices have been proposed for the purpose of preventing a spark at the point of rupture of cables used in pit work. There is room for doubt as to the likelihood of these devices performing their functions in case of need. There can be no question that the concentric cable is much more simple, and it is probably more reliable than any of them. Further, none of these arrangements afford to the miner the immunity from personal danger from shock which the concentric cables does. An E.M.F. of 500 volts is frequently used for such work, and it is usually considered that such a pressure, although sufficient to give a disagreeable shock, is not dangerous to life. That this feeling of security is not well founded is unfortunately proved by recent fatal accidents. For power transmission in mines an ideally safe system is furnished by concentric cables with earthed sheathing, and switches, fuses, and other appliances enclosed in cast iron cases, also earthed, and, if need be, enclosed-type motors with their casings earthed.

With regard to the wiring of ships, it is well known that an essential condition of durable wiring is that it shall be waterproof throughout. The British Admiralty for years tried all that the best materials of the usual double wiring sort, and most careful workmanship, could do to secure the desired result. But the incessantly recurring faults and derangements drove them six years ago to abandon wood casing and the ordinary rubber insulated conductors, and no longer to attempt the impossible. At the time indicated they discarded wood casing, and adopted in lead sheathing of the conductors the most effectual means of rendering them permanently waterproof. It was not, howerever, till four years later that they fully faced the question of making the wiring systematically waterproof throughout. Cast-brass distributing fuse-boxes, and cast-brass switch-boxes, all of waterproof patterns, were then adopted, and means taken to make watertight joints between these boxes and the lead conductors. The present patterns of distributing boxes, &c., although they serve their purpose, are still capable of improvement, and their awkward styles admirably illustrate the difficulty of designing waterproof fittings for use in a double-wire system, where the two sides of the circuit must be insulated from each other, and both from metal of the containing boxes. The Admiralty still adhere to double wiring owing to fancied danger of compass disturbance from concentric wiring. In the early days of electric lighting some of Her Majesty's ships were single-wired, and had dynamos of unsuitable types injudiciously placed. The results were compass disturbances. (The risks of compass disturbance, even from single wiring, are as nothing when compared with those which may arise from the dynamos.) The navigating officers naturally became alarmed, and the alarm has not yet subsided. That well-arranged concentric wiring has no effect whatever upon the compasses of a ship has been proved by the most careful tests. The waterproof qualities of concentric wiring and the safety from fire which it ensures peculiarly adapt it for use on board ship. The history of the development of electric light wiring in our navy is highly interesting and instructive. The conditions to be endured by wiring on board ship are admittedly severe, but it is under these circumstances that the inherent defects in a system will be most rapidly disclosed. We may profit by the experience of the Admiralty, and accept their progress as an index to the direction in which wiring practice on shore should be improved. The same defects which led to the abandonment of double wiring in wood casing in the navy exist in this system when applied to land work. The conditions on shore are less trying, and severe treatment less frequent, but the same inherent defects are there, and only await opportunity to develop.

And now with regard to possible electrolysis due to difference of potential along the outer conductor. In isolated installations where the distances are short the question of electrolysis may be dismissed as having no bearing. In cases where the distances are considerable the risk of electrolysis may be entirely avoided by adopting very simple precautions. The first of these—suggested to the writer by Mr. T. B. Murray—is to so proportion the conductivities of the inner and outer conductors that the fall in volts shall be nearly all in the inner conductor; the copper saved from the inner conductor being added to the outer in order to reduce to a minimum the difference of potential between its ends. Another method adopted by the writer is to provide between the outer conductor and its lead sheathing a very light insulation, and to earth the outer conductor only at the distant end. The layer of braiding laid for manufacturing reasons over the strands of the outer conductor before it is passed through the lead press is sufficient for the purpose, as the maximum difference of potential between the outer conductor and the lead is only a few volts.

The risk of electrolysis is greatly over-estimated. The prejudice against earthing the return conductor is largely due to the results of the early American practice of using an earth return for street railway circuits, instead of providing an adequate return conductor. The consequence of this habit was serious damage by electrolysis to gas and water mains. But what were the conditions? In many cases the current was put to earth at the distant points at 50 volts to 100 volts above the E.M.F. of the dynamo negative, and the large currents, amounting sometimes to thousands of amperes, which had to find their way to the earth plates at the power house carried destruction in their path. But disappearance of these troubles has followed efficient bonding of the rails and the provision of complete metallic circuits of suitable conductivity —in other words, the substitution of a metallic *earthed* return for an *earth* return. In dealing with distribution for electric lighting purposes we do not have to contend with such large differences of potential at different points of the system, and the difficulties are not at all comparable with those encountered in street car work.

A three-wire system with the middle earthed, and concentric wiring on each side with the sheathing connected to the middle wire, is an ideally safe and reliable system of distribution. In a well-balanced three-wire system the fall of volts along the middle wire is negligible, and there is therefore no danger of electrolysis. No disturbance to telephones could take place. Stray currents passing between faults in the conductors would be impossible. The positive and negative conductors being each surrounded by an earthed sheathing, no current can escape from them. Leaks in concentric cables will not endure. The distance between the inner conductor and its sheathing being only the thickness of the insulation, a fault develops at once into a short-circuit which is internal to the sheathing of the cable, and the fuse at once comes into operation. But it must be repeated that faults are much less liable to occur in concentric cables than in double wiring. The importance and safety of the self-testing properties of concentric wiring must be obvious. As distributing networks are enlarged and extended, and the number of consumers increases, it becomes cumulatively more difficult to keep up the pretence of insulation. The present supposed insulation of the three wires is a sham, and the sooner we acknowledge it the better. Experience has proved that good insulation of all three conductors in an extensive network cannot be reliably maintained. Then why not face the difficulties, and end them by earthing the middle wire.

The initiation by Mr. Sidney Baynes of the use of 200-volt lamps and 400-volt distribution on the three-wire system has a significant bearing upon this question. That his policy from the supply engineer's point of view is a sound one is beyond doubt, and that it will be largely followed in the near future is certain. But what about the interior wiring? If the attempt is to be continued to maintain the insulation of all three wires, the possibility is introduced of having a difference of potential of 400 volts between one of the wires and earth. The danger from leakage across damp woodwork and the like is therefore much increased, and possible danger to life introduced.

Recent developments and experience demand the reconsideration of this question of earthing in its relation to electric light conductors. The Board of Trade have issued regulations referring to the use of uninsulated conductors for tramway and railway work. The time is ripe for the framing of regulations relating to an uninsulated middle wire in the three-wire system of distribution.

ARE PATENTS USELESS?

BY W. C. DODGE.

In The Electrical Engineer of Nov. 20, 1895, I noticed the interview of Mr. Rufus R. Wilson with Mr. Edison, in which the latter is represented as saying in a general way, that his patents while profitable to others, have cost him more than he has realized from them; and that in most cases he would advise young inventors to not take out a patent.

Mr. Edison has taken out more patents than any other man in the United States if not in the world; 541 that I know of, and perhaps more; and his inventions have undoubtedly worked greater changes and produced more wonderful results than those of any other one inventor. For these reasons I entertain for him and his remarkable genius the most unbounded respect and admiration, although I have never enjoyed the pleasure of his personal acquaintance.

But notwithstanding my great admiration of him as an inventor, I cannot agree with him in his views as to the uselessness of patents, or that his patents have not paid him more than they cost him.

While it may be true that some of his patents or inventions have cost him as much or more than he sold them for, yet is it not equally true, that all he has he owes to his patents?

As has been told time and again, he was without means when he began, and it is generally understood that he is far from being poor now. How and where did he obtain his wealth, if not from his patents? "From the business," he may reply, built up by himself and associates all over the country. Admit it, but how would he have induced others to engage in and build up that business but for his patents? He ought to know, as we all know, that it was the hope of protection by his patents that induced capitalists and business men to invest their money in the working of his

inventions. Had he not patented his inventions no such results would have been secured and he would have been to-day a comparatively poor man, beyond doubt.

As I am informed, his magnificent laboratory, supplied with material and means such as no other inventor ever had, and by which with the aid of his assistants he was enabled to conduct his endless experiments, was built with money derived from the sale of one of his earlier patents.

The patent office records show that up to August, 1895, he had assigned to the General Electric Company, in which he is largely interested, no less than four hundred and two patents!

Others of his patents he has sold to the Western Union Telegraph Co., while his magnetic separator, phonograph, kinetoscope and other inventions have all been patented and sold or used.

It therefore seems clear that his patents have not proven useless to him, and that so far as the resulting business is concerned, he should rejoice that he did patent his inventions.

On the other hand, Mr. Edison has much reason for complaint of the manner in which some of his patents have been treated by the courts; and it is this I apprehend, that makes him feel aggrieved, and led him to say what he did as to the uselessness of patents.

But he should see, as others have long seen, that the remedy for this is not in decrying patents or the patent system, which I contend has done as much if not more for the growth and prosperity of our agricultural as well as our mechanical industries, as the tariff ever has. It is the genius of our inventors, spurred on by the hope of gain under a patent, supplemented by the skill and versatility of our people that has built up the nation from its infantile condition in 1776 to what it now is, the richest nation on the globe.

To realize what our patent system has done for us, one needs to go back and see what our condition was in the Colonial days, when the so-called "Mother country" suppressed every species of mechanical industry, and when, as Lord Chatham said, he "would not permit the colonists to make so much as a hob nail for themselves!" But all that is foreign to the present subject, and besides it would require a volume to do the subject justice. The remedy for the ills of which Mr. Edison and many others justly complain, is two-fold: First, there should be a complete reorganization of the Patent Office bureau. It is like a man trying to wear the clothes that fitted him when a child. They are too short at both ends, split up behind and down in front.

The Patent Office should be separated from the Interior Department and made an independent bureau. It is much larger now than the entire Department was when first established in 1848.

Then, and for years afterwards, the Agricultural Bureau was attached to the Patent Office. Now that is a separate Department, with its own building, and its head a Cabinet Officer, simply because it is in the interest of a large mass of voters. That is supported by large appropriations from the National treasury, while the Patent Office pays its own expenses and adds about $150,000 per annum to its surplus fund, which on July 1, 1895, amounted to $4,566,757.73.

It is crowded out of its own building, for the erection of which over $360,000 was taken from the patent fund. All this is simply because the inventors constitute but an insignificant fraction of the voters of the country, and have no political influence. They are scattered, one here and another there, over the country, so that, aside from a few like Edison, Brush and Bell, whose reputations have become world-wide, not one member of Congress in twenty knows a single inventor in his district, and the manufacturers, nine-tenths of whose business is built on patents, devote all their efforts to the tariff, and none to the protection or perfection of the patent system.

The Patent Office should be given the possession of its entire building, and should be permitted, as formerly, to use enough of its own funds to provide it with all the help and facilities necessary for the prompt and proper transaction of its important duties.

It should be removed wholly from political influence, and a Commissioner appointed solely upon the ground of his knowledge of, and qualification for the business, with a salary that would command the best talent, and he should be appointed as United States Judges are, for a long term up to a specified age, or during good behavior.

Examiners should be selected who have a practical knowledge of the arts to which their classes relate, should be paid a salary sufficient to secure the most competent men, and should be required to serve for a specified number of years, so as to prevent the early resignation of the ablest men as soon as they have learned the business, thereby leaving the least ambitious and competent, resulting necessarily in "the survival of the *un*fittest."

Second, there should be established a special court for the trial of patent causes, to whom all appeals from the Patent Office should also be taken direct from the Examiners-in-Chief, the Commissioner, with the multiplicity of his other duties, not having the time to wade through the testimony and hear arguments in interference and other appeal cases.

That court, which was recommended by Commissioner Leggett, and subsequently favorably reported by the Judiciary Committee of the House, should be composed of able men who possess a knowledge of mechanism as well as of patent law, so that they could decide cases understandingly and promptly, and with some uniformity by which both the public and the Patent Office could be guided with some degree of certainty, and not, as now, having a court in one circuit deciding one way, and another, another way, and the various examiners following one decision, and another, another decision, thus creating confusion among all parties interested.

This, of course, is but an outline of what should be done, and which it will take years probably to accomplish. If now Mr. Edison and the companies using his inventions, together with other manufacturers, instead of spending their time in complaints, will but unite and bring but a fraction of the influence to bear on Congress on this subject that has been on the tariff, we can have these matters arranged as they should be. When that is done, the grounds for complaint will be removed, and the American patent system rendered complete, and more effective for the protection of inventors and the benefit of the country than it now is, great as its present benefits are.

ECONOMICAL RESULTS IN MODERN ISOLATED ARC LIGHTING.

BY F. E. DRAKE.

MUCH has been said and written about economies which might be practiced in isolated lighting plants, but as yet very little actual data has been presented to the public bearing upon the cost of operating an isolated arc lighting plant, and showing what might be done with modern machinery if properly installed and then operated by careful and competent hands. The plant which is the subject of this paper is that owned by J. L. Hudson, the successful clothier, and lights his handsome store in Detroit, Mich. It was purchased in 1891 and installed under the direction and advice of well-known authorities on electrical and mechanical engineering of the University of Michigan.

The steam plant consists of return flue tubular boilers and modern high speed automatic engines, all well placed and equipped with devices and accessories for economical operation.

The electric plant as installed consisted of five "Standard" arc dynamos of 40 lights capacity each, 205 "Standard" double-service arc lamps, and a 200-light direct current 110-volt dynamo wired for full capacity. The plant was formally started September 1, 1891, and has been operated every working day since.

By courtesy of Mr. A. F. Chappell, Chief Engineer, who has been in charge of the plant since completion, an itemized account of the operating expenses has been furnished the writer. The record is in detail for the full period of four years and four months from September 1, 1891, to January 1, 1896. Time and space is too limited to show the detailed record for each year, but for a comparative basis the expense for the year 1895 is given. In the item of repairs on dynamos the $335.44 includes $200 expended in changing one of the 40-light arc dynamos into a 50-lighter.

In arriving at the average cost per lamp the 200 incandescent lamps are computed as the equivalent of 20 arcs. Each arc lamp is adjusted to 50 volts and the dynamos being wound for 10 amperes it will be seen that each arc consumes 500 watts. The following table shows the record of output.

	For 4 years and 4 months.	For 1895.
Arc lamp hours	1,527.538	351,658
Arc K. W. hours	763,769	175,829
Incandescent lamp hours	2,735,766	1,038,836
Incandescent K. W. hours	150,467	57,186
Cost per K. W. hour		$0.03145

In reviewing the cost per lamp for 1895 one will note in the table that the three chief items of expense are $13.79 for labor, $9.71 fuel, and $2.75 for carbons, figures which are quite phenomenal when the output is considered.

Perhaps the most startling figures shown is the extremely low cost of dynamo and lamp repairs. In 1895 the total of dynamo repairs including brushes was $30.85 or $5.14 per dynamo. Can a better showing be hoped for? The 205 arc lamps had repairs to the extent of $85.90 or 42 cents per lamp, which covered all globe breakage. These results are well worthy of emulation and show conclusively that the oft repeated cry of "economy" has been heard and heeded by the owner and operators of this plant.

Instead of giving the lighting plant credit for exhaust steam at its estimated value, Mr. Chappell has made the set off by reducing the depreciation percentage on the engines and shafting, and the interest charges on a sum placed at $6,000, which the owner after several years' experience, testifies to as being fair and equitable.

Every station man may study these results with some degree of benefit to his plant and purse, and we can none of us afford to say, or believe that we have practiced all economies possible in

generating and distributing electrical energy, whether it be expressed in arc or incandescent lights or power.

DETAILED COST OF OPERATING 205 ARC AND 200 INCANDESCENT LAMPS IN THE J. L. HUDSON BUILDING, DETROIT.

AVERAGE IN LAST COLUMN ON BASIS OF 225 ARCS.	For entire period of 4 years and 4 months.	For the year 1895.	Cost per lamp 1895.
Coal	$8,884.19	$2,185.70	$9.71
Carbons	2,979.81	618.00	2.75
Labor	14,012.09	3,102.48	13.79
Water for boilers	452.09	86.00	.38
Soap, soda, mops and brooms	128.76	12 35	.06
Cylinder, dynamo and engine oil	1,004.28	181.74	.81
White waste	165.15	29 82	.13
Incandescent lamp renewals	807 85	110 83	.49
Incandescent wiring	422.50		
Repairs on boilers and furnaces	794 66	311.33	1.38
Repairs on clutches and shafting	41 85	8 31	.03
Repairs and packing for engines	110.26	45.36	.20
Repairs on 205 arc lamps	163.02	85 90	.38
Repairs on 6 dynamos, including brushes	* 335 44	30.85	.14
10 per cent. depreciation on boilers, $2,000	866.66	200.00	.88
2 per cent. depreciation on engines and shafting, $4,000	346.66	80.00	.36
4 per cent. interest on $6,000	1,000.00	240.00	1.07
Total	$32,464.77	$7,328.12	$32.56

* $200 of this sum expended in an exchange

PROF. RONTGEN'S PHOTOGRAPHIC WORK.

A SPECIAL dispatch from London of Jan. 25, to the *New York Sun*, says :—Never in the history of science has a great discovery received such prompt recognition and been so quickly utilized in a practical way as the new photography which Prof. Rontgen gave to the world only three weeks ago. Already it has been used successfully by European surgeons in locating bullets and other foreign substances in human hands, arms, and legs and in diagnosing diseases of the bones in various parts of the body. It is almost an old story now in its first features, and these seemingly miraculous photographs are easily produced in many physical laboratories, while technical journals are publishing reproductions in their pages. The fact that only a faint idea has yet been gained of the practical possibilities of this discovery is already proven, and it is difficult to keep pace with the astonishing supplementary disclosures.

The most important of these is the application of the new omniscient agent to metallurgy. It has been found that although most metals are apparently opaque to the rays of this strange light or force, yet any internal defects or lack of homogeneity in them are quickly detected and recorded on the telltale plate. The sensitiveness and accuracy of the negatives in this respect are described as marvellous.

No two metals are alike under this new test. Lead proves to be almost as transparent as aluminum and wood. Hitherto it has not been possible without a complicated process to test the uniformity of structure of metal work, for instance, gun barrels, iron rails, railroad wheels, or to distinguish at sight the different varieties of iron and steel. All this, it is anticipated, will be shortly achievable by the help of the new photography. It is no exaggeration to say that this would mean the complete revolution of many branches of metallic industry, especially in the manufacture of arms.

Exact reproductions have been obtained of inscriptions or relief drawings on signet rings and metallic surfaces. To the great astonishment of the experimenters, it was found that metallic objects exposed to Rontgen's rays show in the photographic reproduction all inequalities that exist in the structure of metals, such as fractures and cavities. This quality theorists recognize as being due to the great sensitiveness of the rays to variations in the thickness. All alloys or composite metals—and most of those used in the manufacture of arms are composite—show on the photographic plate whether they are completely homogeneous throughout and where and to what extent one metal, for instance, zinc or copper in the so-called steel-bronze cannon, has not thoroughly amalgamated with another. Owing to the intensity of the photographic picture obtained by the new rays, carbon is readily distinguished from iron, and hence it will be possible to recognize the quality of iron or steel. The rays will also probably furnish a simple method of control in the Bessemer process.

The inference from the latest experiments is that nothing is absolutely impenetrable to these strange rays. There are only varying degrees of transparency or opacity. Prof. Rontgen took a photograph the other day of a large metal plate which had been broken in various pieces and welded together, and so carefully joined that the lines of fracture were imperceptible under the strongest ordinary light. The so-called X rays made them as plain as day on the photograph.

Prof. Czermark of Graz has succeeded in photographing a living skull without its fleshy integument. The editor of the *Grazer Tageblatt* offered his head for the purpose. When he saw the result he positively refused to allow the picture to be reproduced or shown to anyone except to men of science. It is reported that he has not slept a wink since he saw his own death's head. I have already mentioned the important fact that these strange new rays are incapable of being deflected by lenses or any substance. Prof. Rontgen deduces from this that perhaps the rays move with the same volocity in all bodies and in some all-pervading medium with which the molecules of all bodies must be surrounded. No effect could be observed on these rays by magnetic influence. From which fact Prof. Rontgen argues that they differ from Cathode rays, investigated by Prof. Lenard. To the question what are these X rays, if they are not Cathode rays, Prof. Rontgen brings forward the hypothesis that possibly their existence may be ascribed to longitudinal waves in the ether. The existence of such longitudinal waves, as apart from the transverse vibrations which account for the phenomena of light, has before now, from theoretical considerations, been suspected by physicists, although there has been no experimental evidence yet brought forward to show their existence. If this should, on fuller investigation, really turn out to be the case, and the X rays of Prof. Rontgen are really due to such longitudinal vibrations, a great step forward will have been made in the theoretical conception of wave motion.

There are already several claims that Prof. Rontgen's discovery had been anticipated. The photography of the invisible has been accomplished before, but not, Prof. Rontgen protests, by his method. The most remarkable instance was an experiment by Prof. Zeugen in 1885. He focussed Mont Blanc in an ordinary camera toward evening from the window of a hotel at Geneva. He waited until he could not discern a vestige of the mountain through an opera glass, then opened the apparatus and left the plate exposed until midnight, when he found he had obtained an excellent picture. He explains the process thus :

It is clear that in an electric discharge from mountain tops toward the heavens above them the mountains are negative poles while the clouds represent positive poles. Now, the cathodic light thus produced is too weak to light up the mountain in the middle of the night so as to make it visible to the human eye ; but the strata of ice and chalk embedded in it are excited to lively fluorescence and phosphorescence, and thus are very sensitive to photographic plates, which receive the picture in the darkest night.

THE ELECTRICAL POTENTIALS AND ACETYLENE GAS.

About one hundred gentlemen, including the leading electricians and gas engineers of New England, were in attendance at the monthly dinner of the "Electrical Potentials" which was held at the Quincy House, Boston, Tuesday evening, Jan. 21st. The dinner itself was a decided success as were also the proceedings that followed. The subject for consideration was introduced by Mr. W. R. Addicks, engineer of the Bay State Gas Co., which has recently purchased the rights for the city of Boston and town of Brookline, to manufacture Acetylene gas.

Mr. Addicks read a paper on the new illuminant, in the course of which he related the results of his recent visit to the works of the Calcic Carbide Co. at Spray, N. C.

An interesting discussion followed, the consensus of opinion being that both gas and electricity had little to fear from the advent of the new candidate for popular favor, and that it was more than likely to find its more general use as an enriching medium for coal or water gas.

Seventeen new names were added to the list of "Electric Potentials" before this, the most interesting meeting yet held, adjourned.

MORE PLANS FOR NIAGARA FALLS, N. Y.

The "Model City" which includes large blocks of real estate in the vicinity of Lewiston, just at the outlet of the Niagara Gorge into Lake Ontario, is now being pushed. The company makes the positive announcement that it has made a contract to furnish 25,000 horse-power to a company that will invest $10,000,000 in the manufacture of iron and steel in Model City. It is claimed that leading iron and steel men are in the enterprise, that 5,000 men will be employed and 1,000,000 tons of finished steel turned out annually. It is also stated that steel can be manufactured in Model City $2 per ton cheaper than in Pittsburg. The sites for manufacturing plants will be furnished free and power will be sold for $10 per horse per annum, with 24 hour day. The company will now push forward their canal which was commenced last year to completion. It will be ten miles long, forty feet wide and twenty-five feet deep. So they say.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS ISSUED JAN. 21, 1896.

Dynamos and Motors:—

Alternating Current Motor, M. Hutin and M. Leblanc, Paris, France, 553,469. Filed Nov. 17, 1892.

Object of the invent'on is to construct and operate alternating current electric motors that the torque of the armature or rotating part shall be a constant maximum whatever the speed of rotation may be.

Electrolysis:—

Apparatus for Electrolyzing Chloride Solutions, E. Hermite, London, Eng., 553,464. Filed June 22, 1895.

An anode for electrolyzing purposes, consisting of a glass plate and a network of platinum wires strung on opposite sides of said plate.

Apparatus for Electrolyzing Chloride Solutions, E. Hermite, London, Eng., 553,465. Filed June 22, 1895.

Relates to apparatus of a simple kind for the purpose of electrolyzing chloride solutions for the production of disinfecting-liquid, and automatic regulating apparatus.

Lamps and Appurtenances:—

Art of Manufacturing Electrical Incandescing Conductors, J. W. Aylsworth, Newark, N. J., 553,296. Filed July 27, 1894.

For description see page 111, this issue.

Incandescing Electrical Conductors, J. W. Aylsworth, Newark, N. J., 553,323. Filed July 27, 1894.

Similar to above.

Electric Arc Lamp, E. H. Crosby, Boston, Mass., 553,335. Filed May 27, 1895.

A stage arc lamp with inclined carbons. Relates especially to means for preventing sticking.

Miscellaneous:—

Electric Gas Lighting Apparatus, H. C. Farquharson, New York, 553,304 Filed Nov. 4, 1895.

Similar to patent below.

Electric Gas Lighting Apparatus, H. W. Brinckerhoff, Brooklyn, N. Y. and H. C. Farquharson, New York, 553 330. Filed Apl. 8, 1895.

Device for lighting railway gas lamps by electric spark.

Magnetic Extracting and Separating Machine, F. J. Barnard, J. C. Moore & J. D. Atkinson, Seattle, Wash., 553,446. Filed Feb. 27, 1895.

Details of construction.

Railways and Appliances:—

Electric Railway, W. M. Schlesinger, Philadelphia, Pa., 553,264. Filed Dec 21, 1886.

In an electric railway the combination of a working conductor comprising a series of insulated or disconnected sections, a series of separate feeding conductors for supplying said sections, conductors constituting paths of high and low resistance interposed in said feeding conductors, safety devices in the conductors of low resistance, and return circuit connections opposed to said sections.

Trolley, W. Kaup, Newark, N. J., 553,410. Filed June 7, 1895.

Provides trolley wheel guards in connection with reversible trolley poles; prevents interference of parts such as will derail the trolley and renders the trolley guard automatically adjustable in relation to the poles.

Telephones:—

Telephone Call, J. G. Smith, New York, 553,364. Filed Aug. 17, 1895.

Consists in a main line having a signaling instrument, a magneto or dynamo electric machine located on a normally open spur circuit leading from the main line and means for opening or breaking said main line and introducing said spur circuit, includ ng said magneto, into said main line.

Telephone, S. A. Dinsmore, Chicago, Ill., 553,452. Filed Apl. 22, 1895.

For description, see page 123, this issue.

LEGAL NOTES.

A RULING ON STREET CARS AND FUNERALS.

Judge Brill, in St. Paul, Minn., has filed an order granting the motion of the defendant for a new trial in the personal injury damage suits of Theodore H. Johnson and Sarah S. Johnson against the St. Paul City Railway company. These suits grew out of a collision between Johnson's carriage and a street car at the corner of Broadway and Eighth street last spring. The carriage was being driven in a funeral procession that was crossing Broadway, and the motorman attempted to run the car across the procession, with the result that the carriage was smashed and Mrs. Johnson, the mother of the first-named plaintiff, seriously injured. The case was submitted to the jury on the theory that the city ordinance providing that processions shall have the right of way applied. But Judge Brill has changed this, and grants the new trial. In the memorandum attached to the order the court says:

After further consideration of the question I have come to the conclusion that section 6 of the ordinance of 1869, relating to fast riding and driving of horses in the streets, does not apply to the operation of street cars. At the time the ordinance was passed street cars were not in use in the city, and the ordinance was intended to apply to such vehicles as are driven about the streets and may be moved from place to place at the will of the driver. The person in charge of an electric car does not drive the car in the ordinary acceptation of the word.

Processions upon the street sometimes are of great length, and occupy a considerable period of time in passing a given point, ten, thirty, forty minutes, or an hour or more. An ordinary loose vehicle can turn aside and proceed upon another street without much inconvenience. A street car is a public conveyance for the transportation of passengers. It proceeds upon a fixed track, and could do nothing but wait, whatever the time might be, and such a rule would greatly inconvenience the public. The interruption to a procession by the passage of a car would at most be slight, and frequently there are breaks in a procession through which the car might pass without interrupting the progress of the procession at all.

Of course, without an ordinance the street car has no greater right of passage than the persons in the procession. The company is liable for negligence the same as in any other case, but these cases were tried and submitted to the jury on the theory that the ordinance gave the procession the right of way, and that to run the car through the procession was negligence per se, and hence there must be a new trial without regard to whether, aside from the ordinance, there was sufficient evidence to sustain the finding of negligence upon the part of the defendant.

PERSONAL.

C. C. CALDWELL, E. E., M. E.

MR. C. C. CALDWELL, E. E., M. E., of 327 Elmira street, Williamsport, Pa., informs us that he expects, within the next few weeks, to open a "Manufacturers' Agency" in that city, and has about concluded arrangements with certain manufacturing firms to represent them in central and northern Pennsylvania, especially in the counties adjoining Williamsport. This is an unusually fine field, there being no supply house or agency within a radius of 150 miles. Mr. Caldwell desires to handle on certain business arrangements the products of some good engine company, a water-tube boiler, a good line of electric light and power and railway supplies, and several other articles to be used exclusively in the fields above named.

Mr. Caldwell has had a practical experience of over ten years, in all branches of electric lighting work, and is fully able to make the designs, purchase all the supplies, handle the men and install complete plants. He will make a specialty of looking after all contracts in Williamsport and vicinity. Mr. Caldwell will be glad to receive catalogues and trade lists.

MR. T. J. CARRUTHERS has been appointed manager and electrician of the Falls City, Neb., plant.

PROF. W. D. MARKS has resigned as president of the Philadelphia Edison Co.

MR. GEORGE J. DAVIS, who for the past four years has been electrician for the Alliance, O., Street Railroad Company, has resigned.

MR. ALBERT SCHMID, Chief Engineer of the Westinghouse Co., left for Europe last Wednesday on a vacation which will extend over several months.

MR. E. F. SEIXAS is in New York City in behalf of the Tennessee Centennial Exposition making arrangements for the electrical effects and exhibits.

DR. J. E. LOWES, president of the local Light, Heat & Power Co., of Richmond, Ind., has been appointed surgeon general for Ohio, and has been presented with a handsome sword of honor for state occasions by his friends.

MR. W. BOARDMAN TOBEY of Pittsfield, Mass., who has been manager of the S. K. C. Electrical Supply Company since its organization, has accepted a position as manager of the Ecuador General Electric Company of Guayaquil, Ecuador, South America. He will leave for his new field of operations about February 15.

MR. LAMAR LYNDON has just started for Japan, in which country he will represent a number of manufacturers of standard electrical apparatus and steam engines. His headquarters will be as Yokohama, and he can be addressed care of the Hon. Edwin Dun, U. S. Minister, Tokyo, Japan.

MARRIED.

PLUMMER-WHALEY.

Frank O. Plummer, senior member of the firm of Plummer & Ham, Worcester, Mass., and Miss Maud E. Whaley, were married recently at the home of the bride in North Sterling, Connecticut. The ceremony was performed by Rev. F. M. Houghton, of Putnam, a cousin of the groom. The bride was a former resident of Worcester. The groom is a graduate of the Worcester Polytechnic Institute, class of '94, and is an active member of local Masonic bodies.

Trade Notes and Novelties
AND MECHANICAL DEPARTMENT.

THE AMERICAN CARBON CO.

A notable impression was made at the recent Northwestern Electrical Convention by the American Carbon Co., of Noblesville, Ind., which has the support of large financial interests in Indianapolis, and is in the field as a wholly independent company for the manufacture and sale of the highest grade of carbons. The company has placed itself squarely on record as an anti-trust organization, but is not merely satisfied with making that its war cry and seeking a sympathetic market. It believes that public feeling is with it, in the electrical trade, but it also believes in making and selling the best article, and this is the real point at which all its endeavors have been consistently and persistently aimed. It invites correspondence and orders, and offers the best goods at fair prices.

RUMOR AND DENIAL.

"Reported that friends of Westinghouse have made an agreement with General Electric people by which 150,000 shares of General Electric, 6000 Westinghouse common and 10,000 Westinghouse pfd. are to be put in trust and a business agreement made."

"The report regarding agreement between Westinghouse and General Electric companies is a N. Y. Stock Exchange story and we are authorized by General Electric people to deny it officially."

"Activity in General Electric is on a report that a Boston banker, known to be in friendly relations with the Westinghouse Company, has received an offer of a seat on the Board of Directors. This is regarded by recent Boston buyers as evidence in favor of the report of steps toward a better understanding between the two companies."

THE MAYRHOFER STAGE LIGHTING COMPANY.

The remarkable success achieved by the Mayrhofer Stage Lighting Co. in the equipment of theatres, has made its present shop facilities too small to handle the business, and the Company has therefore made arrangements with the General Incandescent Arc Light Company, of New York, who will in the future manufacture their apparatus. The headquarters of the Mayrhofer Stage Lighting Co. have been removed to the offices and factory of the General Incandescent Arc Light Co., 572 First Ave., New York.

Among the recent installations completed by the Mayrhofer Company is the Valentine Theatre at Toledo, Ohio, and the Mayrhofer stage regulators are going in all over the country. Their remarkable compactness and the fineness of their gradation make them favorites in this line.

The Company have also just secured the contract for the lighting of the Academy of Music, Jersey City, N. J.

NEW OFFICES OF THE STANDARD AIR-BRAKE CO.

The business of the Standard Air-Brake Company has increased so rapidly that it has become necessary to secure larger office space and better facilities. In considering the different buildings adapted to their use, the Company decided that the American Surety Company's mammoth new structure at 100 Broadway would be the most desirable headquarters. A suite has been rented on the tenth floor giving abundance of light and air. The view from the offices is fine and takes in the harbor and river. The removal occurred on the 21st inst., since which date the Company's headquarters have been in the American Surety Company's building. Mr. Wessels says the latch-string will hang out and that he will be glad to welcome old and new friends in the new offices.

WHITTINGHAM ELECTRIC CAR HEATERS.

Recent sales of the Whittingham Electric Car Heaters have been made as follows:—City & Suburban Railway Company, Baltimore, Md., 21 heaters; Baltimore Traction Company, Baltimore, Md., 5 heaters; Second Avenue Traction Company, Pittsburgh, Pa., 12 heaters; Ithaca Street Railway Co., Ithaca, N. Y., 5 heaters; Cortlandt & Homer Traction Co., Cortlandt, N. Y., 2 heaters. Heaters have also been shipped to the following roads: Montreal Street Railway, Montreal, Can.; Belle City Railway Co., Racine, Wis.; Terre Haute Electric Railway Co., Terre Haute; Consumers Electric Lt. & St. Ry., Tampa, Fla.; North Chicago St. Railway Co., Chicago, Ill.; Winnipeg Elec. Street Railway, Winnipeg; Bloomington Street Railway Co., Bloomington, Ill. An extract from letter recently received from Mr. D. Thomson, Supt. of the Ithaca Street Railway, Ithaca, N. Y., says: "We are pleased to note that, so far, we have had so much satisfaction with the use of the heaters that we have no hesitation whatever in saying that they are the best thing in the market, of which we have any knowledge, and it is the writer's opinion, that you should in some way make them more extensively known, and their adoption would surely be more universal. You should particularly impress upon any one using car heaters, the fact that your heaters are clean and sightly, and that the heat is not intense at any one point, but is evenly distributed throughout the entire length of the car. In almost every other heater that is on the market, the exact reverse of this is the case. Then again, with the old style open resistance coil heater, the heat is so intense in some of them, as to not only scorch the seat rugs of the car, but sometimes the passenger's clothing. The heaters in our cars are often taken for hot water heaters, and are a mystery to the passengers, as to how they are heated."

BALL ENGINES IN THE ELECTRICAL FIELD.

The Ball Engine Co., Erie, Pa., make an interesting and suggestive note of work going through their shops, where the engines are intended for the electrical field. The range of use shown is very remarkable:—

A cotton works, three coal mines, a tin plate mill, a large lake passenger steamer, a spinning works, two steel works, a shoe factory, a manufactory of mats and rugs, a car works, a knitting works, a hotel, a wood working plant, a state reformatory, a state insane asylum, an apartment house, two bank buildings, four office buildings, three store buildings, besides engines for electric light and railway power stations. A large proportion of these engines are to be direct connected to dynamos of the standard types, showing the close connection at the present time of steam and electricity.

ADVERTISERS' HINTS.

Micanite was largely used in the De Ferranti alternator at Deptford, England (the armature of which weighs 35 tons), and has given excellent results, having been tested up to 25,000 volts. Micanite is the specialty of the Mica Insulator Co. of this city.

A Gold Medal and Diploma has been awarded to Hanne Bros. at the Cotton States Exposition for the best wire reel. The reels are adjustable and are sent on trial to any responsible party.

The Electric Appliance Co. state that the high grade of Paranite wire has always been maintained, making it of especial value where the conditions of service are severe.

The Sunbeam Incandescent Lamp Co. are again advertising their lamps now so long and favorably known.

The Central Electric Co. call attention to their large stock of telegraph instruments—keys, relays, sounders, batteries—in short everything.

The Beacon Lamp Co.'s catalogue of multiple series, miniature and decorative lamps is now ready and will be sent on application.

John Wedderburn & Co., patent attorneys, of Washington, D. C., invite requests for information regarding their $1,800 prize offer for patentable ideas.

The American Carbon Co. have made it their aim during the past year to manufacture a carbon surpassing all others in purity of light and length of life. They claim to be entirely successful.

NEW YORK NOTES.

The Perkins Switch Mfg. Co., of Hartford, Conn., have appointed Mr. C. I. Hills manager of their sales department, with headquarters at 219 Havemeyer Building, New York City. Mr. Hills has been known for many years as one of the very best lamp salesmen this country has ever produced, and has been associated with the Perkins Switch Co. since they took up the manufacture of incandescent lamps nearly a year ago. There is no more generally popular man in the electrical trade than Mr. Hills, and with the entire management of sales in his hands the Perkins products should become more favorably known than ever before.

WESTERN NOTES.

The Electric Appliance Company has covered the Western States with a calendar that is unique and artistic in design, and contains a Moonlight Schedule that will be found particularly useful to station managers.

☞ *Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Financial, Miscellaneous, etc., will be found in the advertising pages.*

THE
Electrical Engineer.

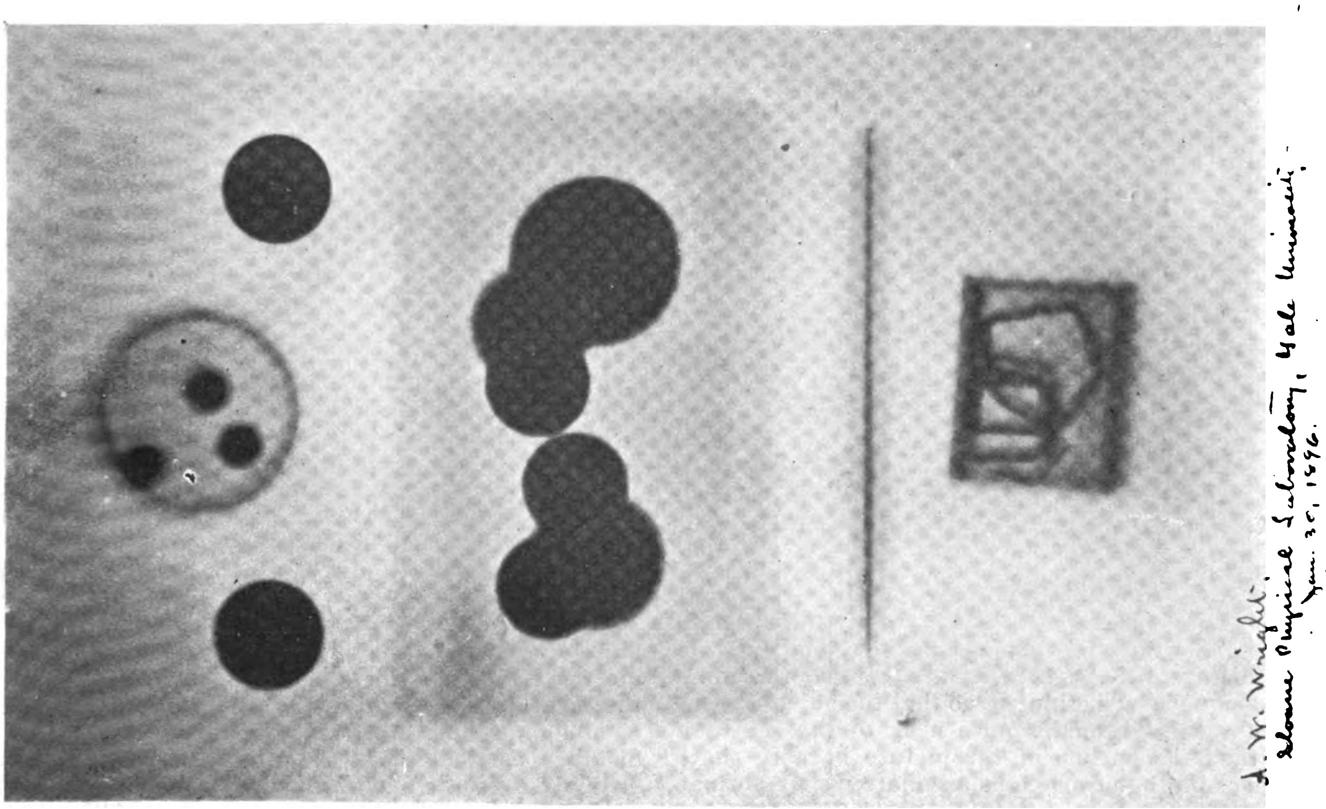
Vol. XXI. FEBRUARY 5, 1896. No. 405.

Electric Lighting.

CATHODOGRAPHS BY PROF. WRIGHT, OF YALE UNIVERSITY.

WE have received from Prof. A. W. Wright, Professor of Experimental Physics at Yale University, New Haven, Conn., a bromide print cathodograph of a number of objects, which we have reproduced in a half tone engraving on this page. Prof. Wright's experiments were made with a great variety of substances, and it was found that strong show the design and lettering on both sides. The two aluminum medals are shown at the left in our engraving, on either side of the three spheres referred to below. Unfortunately the bromide print has not brought out the details of the design and lettering which appear in the original plate. In this experiment the ebonite plate holder constituted the screen between the medals and the sensitive plate.

In other experiments which were made by Prof. Wright with pine board interposed, a closed paper box containing aluminum grain weights left a trace upon the plate which appeared as though the box were almost transparent and the weights themselves some-



Cathodographs obtained With Crookes Tubes by Prof. A. W. Wright, Sloane Physical Laboratory, Yale University, New Haven.

impressions were obtained upon a photographic plate even when it was enclosed in an opaque wrapping of black paper and covered with a pine board half an inch thick. It was evident at the outset that the order of transparency of different subjects for the light rays was very different from that which is found with the cathode rays. Thus pieces of glass were more opaque to these rays than some of the metals or than ebonite, which is perfectly opaque to luminous rays, but transmits the cathode rays with great freedom. Among the metals aluminum is especialy distinguished, and in one of the experiments of Prof. Wright an aluminum medal left its impress upon the plate so clearly as to

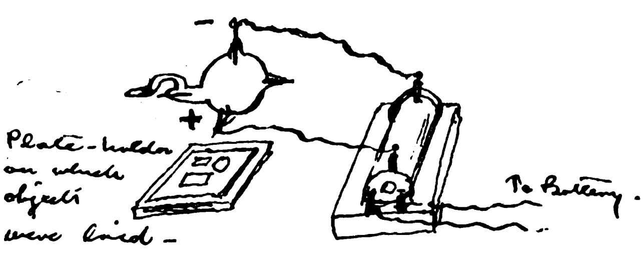
what translucent. This is shown at the right in our engraving. An ordinary lead pencil lying near the box upon the interposed board showed its graphite core by a darker trace in the middle of the fainter impress of the wood of the pencil; seen at the left of the aluminum grain weights.

Another paper box contained embedded in cotton three small spheres, one of platinum, one of brass, and one of aluminum; shown at the extreme left. In this case also the box and the cotton appeared so nearly transparent as to leave but a slight impression on the plate. The brass and platinum spheres intercepted a large portion of the cathode rays, the aluminum sphere

a much smaller proportion. A number of United States coins—silver, copper and nickel—produced strong impressions, showing almost complete interception of the rays, but there were differences, the copper coins transmitting more than the nickel and the nickel more than the silver.

In an earlier experiment a somewhat thinner board of white wood was used, the plate being wrapped in black paper as before. On this board was laid a pocketbook of dark Russia leather with several flaps of leather within, and containing seven cards, two of them thick. A number of coins were slipped into the inside compartment of the book, which was then closed and laid upon the board under the tube. On the plate, when developed, only a faint shading was left by the pocketbook, but the coins left a strong and definite picture, showing with surprising clearness their number and position in the book. This cathodograph is shown in the centre of our engraving. A trace of Prof. Wright's hand, which rested upon the board during this experiment, was also strongly depicted. The outlines of the hand are somewhat blurred, and in the palm faint traces of the passage of the rays between the bones could be detected, but there was little of the effect, reported by Prof. Rontgen, of the greater distinctness of the impression made by the bones.

It will be remarked that the pictures produced on the sensitive plates by these experiments have to the eye an appearance similar to those of shadows thrown by the object upon a surface when the source of light is but a short distance away. If the object is at a



PROF. WRIGHT'S ARRANGEMENT FOR TAKING CATHODOGRAPHS BY MEANS OF CROOKES TUBES.
Autographic Sketch Furnished by Prof. Wright.

short interval from the illuminated surface, the image is somewhat enlarged, also distorted if the rays fall obliquely, and the edges somewhat blurred or diffused. If the distance of the tube is increased or the interposed opaque layer is thinner, so that the object experimented upon is brought quite near to the sensitive plate, then the outline of the picture is more sharp and clear and the proportions are more nearly normal. In Prof. Wright's first successful experiment instead of a photographic plate a piece of sensitive bromide paper was used simply wrapped in stout black paper absolutely opaque, on which the objects were laid, consisting of a pair of scissors, a lead pencil, and a quarter of a dollar. These objects left a strong impression, with remarkably clear outlines of their exact forms.

The reports of Prof. Rontgen's work state that the cathode rays do not suffer refraction, and that therefore no image is formed by the action of a lens through which they pass. Prof. Wright's experiments confirm this, and seem to indicate further that they are not susceptible to double refraction or to reflection. In this respect they are radically different from rays of light, as also from the rays produced by electric oscillations as described by Prof. Hertz.

THE PHENOMENA OF THE CATHODE RAYS.—SUGGESTED APPARATUS FOR THEIR PRODUCTION.

BY

Elihu Thomson

I NOTICE in your valuable journal of the issue of Jan. 22, reference is made, under the heading, "Electric Photography Without Light," to further dispatches from abroad with regard to Prof. Rontgen's work. It occurred to me in this connection that it would be proper to point out the fact that the discoverer of the phenomena of the cathode rays in penetrating opaque bodies was Hertz, and that to Phillip Lenard was due the discovery of the fact that these cathode rays, which Hertz had demonstrated could pass through aluminum shut up in a vacuous chamber, might also pass through aluminum when it was made a part of the enclosing vessel. In this case the rays projected from the vacuous space, passed through the aluminum and into the air, or into the media beyond.

Lenard showed that these rays could penetrate a considerable distance from the aluminum window in the Crookes tube, and that they were capable of causing phosphorescence in much the same manner as when they fell upon substances within the tube; that they would also penetrate metals and many opaque substances, and were capable of acting upon photographic plates which depended upon the relative opacity to the cathode rays, other things being equal. Lenard also showed that the rays were not only capable of passing through the aluminum from the Crookes' tube, but that they were propagated through a vacuum which was made so high that no electric discharge could pass. In other words, when the rays were set up in the Crookes vacuum by an electric current they might enter a much higher vacuum, incapable of carrying an electric discharge, and traverse such higher vacuum. From this he reasoned that the phenomenon was some effect of the ether.

In the absence of any other information concerning Prof. Rontgen's work it would appear that what he has done is simply to magnify Lenard's experiments and apply the principles in somewhat modified ways. Lenard experimented with a very moderate size of apparatus, energized by ordinary induction coils, and it would not be surprising to find that with larger and more powerful sources of current, producing high frequency waves, passing through a vacuous tube, that the cathode rays would be far more intense and might be able to produce much more pronounced actions at a distance, particularly as the property which they most strongly presented in Lenard's experiments was the photographic property or the power of provoking chemical action on salts of silver.

It would seem, therefore, that it might be possible to construct a cathode ray generator consisting of, say, two flat discs or plates of aluminum held apart by insulation, and the space between which is connected to a high vacuum chamber. It would then only be necessary to attach to the plates the terminals of a powerful apparatus giving alternating discharges of high frequency, to set up in the space between the electrodes or plates an intense play of cathode rays, provided the exhaustion was made proper for their development; which rays would pass outwardly through the aluminum sheets and manifest their presence in the medium surrounding the same. Or, it is conceivable that a vacuum chamber might be con-

structed entirely of aluminum with an insulated terminal contained therein, the space between the terminal and the envelope being exhausted to a high degree, and kept so, while the outer envelope and the one terminal were connected to an electric source in like manner. These constructions would not be very difficult to produce if the need should arise, and, if the statements are true that a considerable thickness of aluminum is still transparent to the rays, there must be scarcely any limit to the intensity which might be given to them, while if heat was developed in the passage of the discharges it could readily be carried off by cooling media caused to circulate outside the apparatus. The whole subject is one of absorbing interest, and one which may advance our knowledge of matter and ether, and may, besides, give rise to practical results.

The paper of Phillip Lenard describing his experiments, was, I believe, first published in "Wiedemann's Annalen," and republished in the London "Electrician" of March 23, 1894, on pages 574 and 575, and continued in the issues of March 30 and April 6 of the same year.

It may be possible, as has been stated in some of the newspaper accounts of Rontgen's work, that he holds to the opinion that the cathode rays investigated by Lenard are different from those which the former has been working with. Until, however, further details are received which will enable us to judge of the correctness of this view it will suffice to point out the great similarity between the effects of the rays which Lenard investigated and those which Rontgen is now reported to be using.

PHOTOGRAPHS TAKEN BY THE MOORE "ETHERIC" LIGHT.

THE announcement of the remarkable results obtained by Prof. Roentgen in photographing objects screened from the photographic film by various bodies, with the aid of the rays emanating from Crookes' vacuum tubes, has set many to work repeating these remarkable experiments. In line with these we have deemed it of interest and importance to bring before our readers the remarkable results obtained by the employment of the direct lighting effects of vacuum tubes in the photography of objects in the usual manner.

The results heretofore obtained when vacuum tubes have been used as the source of illumination have resulted in comparatively feeble effects and have failed to give distinct and sharp outlines of the object on which the camera was focused, even with long exposures. What strides have recently been made in this field will be apparent on an inspection of the engraving forming the supplement to this issue of "The Electrical Engineer" and also that shown on this page. Both these engravings were made direct, without the slightest retouching, from photographs obtained by Mr. D. McFarlan Moore in his Newark laboratory by the aid of vacuum tubes excited by discharges made with his ether gap break. The photographs were taken in a room 10 by 11 feet in area, with the tubes disposed around the walls; four tubes being used, 9½ feet long by 1¾ inches in diameter. In the illustration on this page one of the tubes was held by one of Mr. Moore's

FIG. 1.—INTERIOR OF DARK ROOM, MOORE LABORATORY, NEWARK, N. J. TAKEN ENTIRELY BY LIGHT OF CORNICE TUBES SHOWN IN PICTURE. FROM UNRETOUCHED NEGATIVE.

assistants. The number of vibrations employed in this instance was 100 per second, and the time of exposure was three minutes.

In order that our readers may fully understand the means by which these effects were obtained it may be well to recall that the fundamental principle employed in the Moore system of "etheric" lighting, as the inventor prefers to call it, consists in generating electric waves or vibrations suitable for producing luminous effects by interrupting the flow of electric current through a circuit of induction in a high vacuum as contradistinguished from a partial vacuum or one in which the rarefaction has not been carried beyond the point suitable for exhibiting luminous effects. The electric waves or vibrations so generated are made to produce luminous effects by acting upon a receiver containing a rarefied gas.

In order to produce etheric or phosphorescent light there is required a high electromotive force with a short wave length. Heretofore high electromotive forces have been obtained by the utilization of counter electromotive force, due to the breaking of a circuit of high induction; but the degree of the counter electromotive force, or the final voltage obtained, as is well known, depends very largely on the suddenness with which the circuit is disrupted.

As may be seen from Fig. 2, in Mr. Moore's apparatus the circuit through the magnet is disrupted at the contact F, placed within the vacuum tube D, the interposing dielectric being, instead of air, which is a comparatively good conductor, a vacuum of almost infinitely high resistance and inserted in the circuit in a minimum space of time.

Another reason for the results obtained is that, as the vibrator is within a vacuum, it is free to move. That is, it has no air resistance and practically it is proved that it vibrates at a rate of three or four times as fast as the same vibrator would vibrate in the open air.

In the apparatus shown in Fig. 2, the light, of course, is produced at R. The vibrator tube consists of a glass tube enclosing a small bit of iron (the armature) attached to a metallic spring G, and in contact with the metallic point F. It is essential that the vibrator tube D should be exhausted to the very highest degree obtainable, while the tube which produces the light R should have a degree of exhaustion which is comparatively low, and which is that best suited for producing the maximum light. The circuit passes through the magnet C, whose self-inductive discharge is thrown into the tube R. The terminals of the tubes

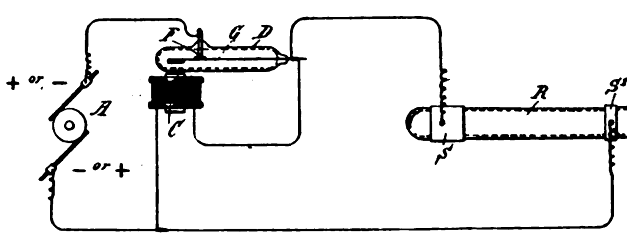


FIG. 2.—MOORE'S VACUUM TUBE LIGHTING SYSTEM.

are coated with metallic paint, and to these coatings are attached the wires. It may be noted that the terminals of the light giving tube can be connected either directly in shunt around the break or around the terminals of the coil.

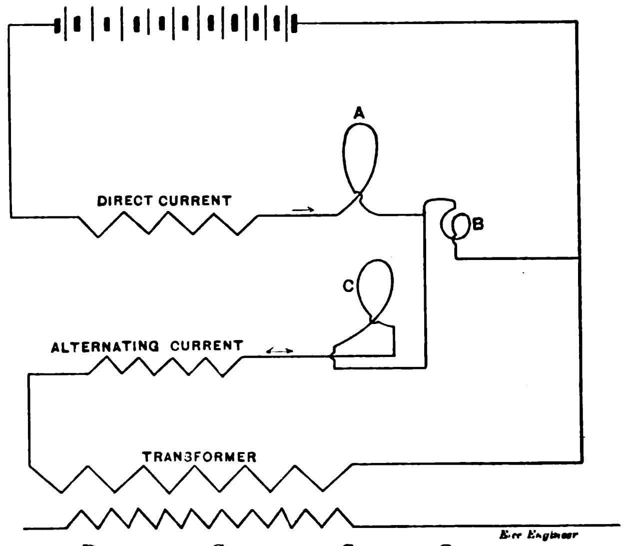
The remarkable clearness of and abundant light shown to be present in the photographs can leave little doubt that vacuum tube lighting has advanced a long way towards practical application in the art of illumination.

In this connection it may not be improper to mention that the Moore Electrical Company has been formed to develop Mr. Moore's inventions in this field. president, Mr. Leopold Wallach, treasurer, and Mr. D. president; Mr. Leopold Wallach, treasurer, and Mr. D. McFarlan Moore, electrical engineer.

A DIFFERENTIAL METHOD OF COMPARING DIRECT AND ALTERNATING CURRENTS.

BY JAMES E. BOYD.

A CONVENIENT method of comparing direct and alternating currents is by means of a dynamometer, on the principle of the differential galvanometer, having a pair of equal fixed coils, one for direct current and the other for the alternating current, and



DIRECT AND CONTINUOUS CURRENT COMPARER.

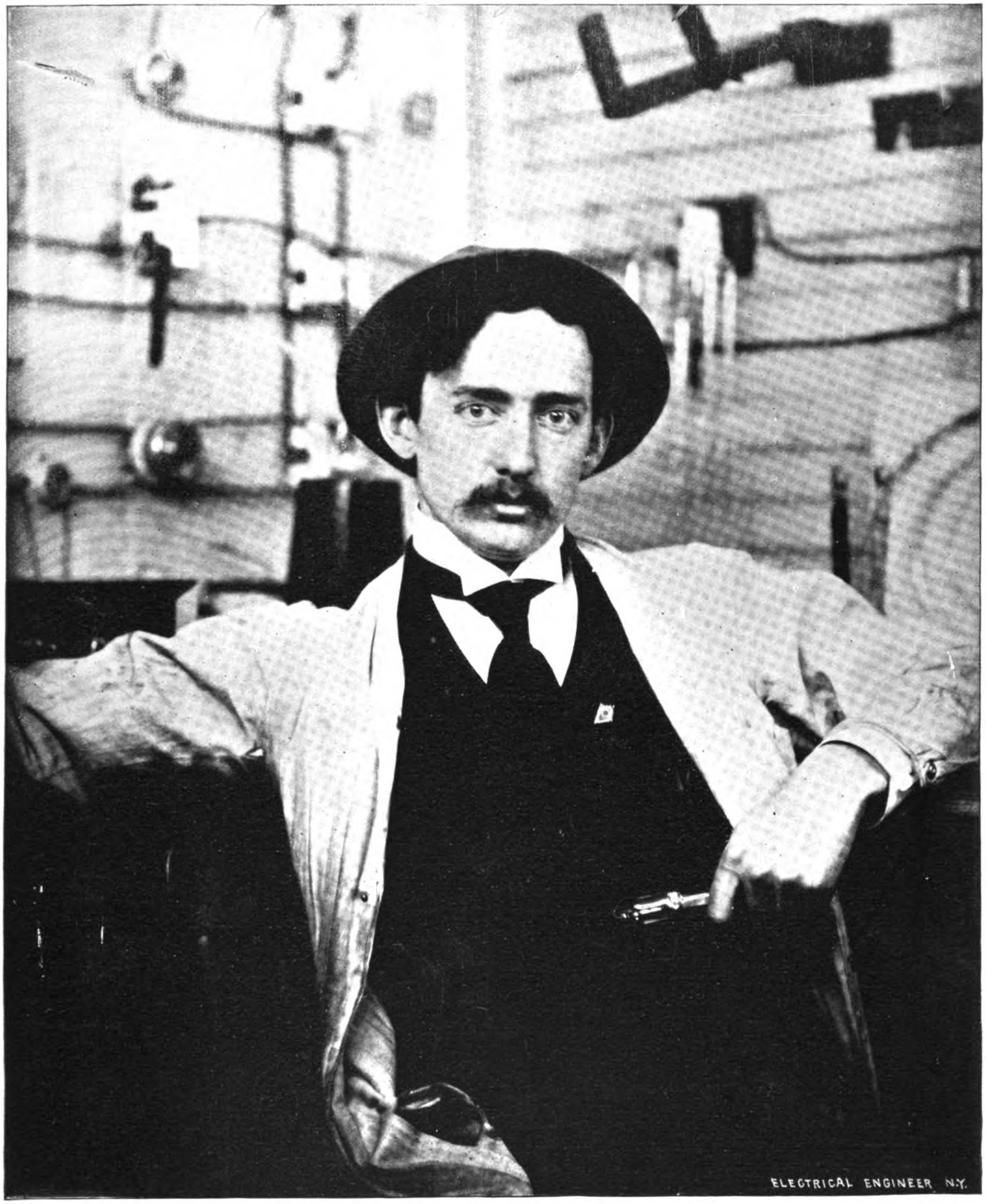
a common movable coil for both. The fixed coils may be made by winding two wires together. They are finally balanced by connecting in series so as to oppose each other, and adjusting an auxiliary coil until a current sent through them produces no deflection.

They are then arranged for use, as is shown in the accompanying diagram, where A and C are the fixed coils and B the suspended coil. The mean force between a direct current in A and an alternating current in B is zero. The torque between A and B is that due to the direct current alone, and in the same way that between C and B is due to the alternating current alone, and when these are equal there is no deflection on making the circuit..

Where it is not desired to connect the two circuits through B, a double coil may be used. The balancing can all be done on the fixed coils in this case. This arrangement has the disadvantge of requiring four connections with the suspended coil, and is, of course, more difficult to wind than with a single coil.

THE BEST ELECTRIC LIGHT COMPANY, of New York City, has been formed to build and operate conduits for wires, with a capital stock of $5,000. The directors are J. A. Gormack, L. Dexter, and F. B. Jacobus, of this city.

LIGHTING THE ELEVATED.—A bill has been introduced in the New York State Senate requiring the Manhattan elevated to use electricity or gas of 18 C. P. in lighting its cars, and forbidding the use of kerosene or coal oils after June next.



Portrait of D. McFARLAN MOORE.

Photograph taken by the Phosphorescent Glow of Moore's "Etheric" Lighting Tubes, by means of "Vacuum Gap" Break.

FROM AN UNRETOUCHED NEGATIVE.

ON THE MOTIONS OF THE LUMINOUS GLOW IN RAREFIED GASES PRODUCED BY ELECTRIC OSCILLATIONS.[1,2]

BY J. ELSTER AND H. GEITEL.

In the course of some experiments on cathode rays, in which a high-tension transformer was used instead of an induction coil, we observed in a Lenard tube[3] a peculiar discharge

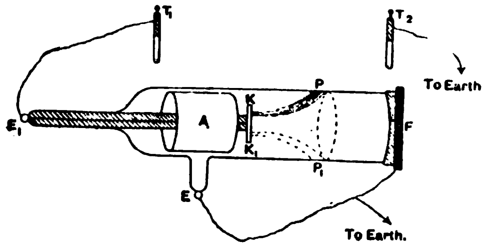


Fig. 1.

phenomenon, the nature of which we endeavored to elucidate by a series of experiments.

For transforming the alternate current of a large induction coil of about 18 cm. maximum sparking distance, we employed the arrangement described by Tuma[4]; the discharge of the attached condenser of large capacity took place between two adjustable zinc terminals, the distance of which in these experiments only amounted to ½ mm. to 1mm, (with larger distances the discharge tube ran the risk of percussion). On joining the aluminum disc K (Fig. 1) with the terminal T_1 of the transformer, while putting the other, T_2, as well as the cylindrical electrode A and the metal cap F, to earth, we observed at a pressure of about 1 mm. the following phenomenon:—

From the electrode K there proceeded a fine light thread KP, bent upwards, which produced vivid phosphorescence both where it originated on the metallic plate and where it impinged upon the glass wall. The phosphorescent patch on the

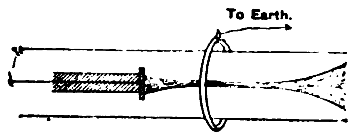


Fig. 2.

(oxodyzed) aluminum disc had a bluish white, and on the glass the well-known green color. Both patches increased in brilliance as rarefaction was carried further, while the luminous thread connecting them steadily decreased in luminosity, and almost totally disappeared at the highest attainable rarefactions. Thus the impression was created of a fine cathode ray, bent upwards, proceeding from the plate K. If a conductor put to earth, say the hand, was brought near this ray from above, it jumped into the position K_1 P_1 (shown dotted in the figure). On passing the hand slowly round, the patch P passed in succession through the positions indicated by the circle P. P. The luminous thread K. P. was always urged on to the opposite side of the glass tube away from the conductor—was, in fact, repelled by it. Insulated conductors acted in the same manner, but much less powerfully. Dielectrics had no effect. The bending upwards of the ray was evidently due to the fact that the discharge tube was rather close to the working bench. The effect of this could be elim-

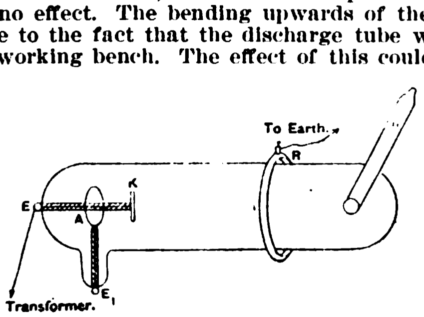


Fig. 3.

inated by placing a metal ring put to earth round the tube. The patch then moved into the center of the plate K, and the luminous ray assumed the shape shown in Fig. 2 without losing its sensibility to conductors approaching from outside.

To follow up the phenomenon further, we now replaced the Lenard tube by a vessel of the shape shown in Fig. 3. In this apparatus the aluminium ring A corresponds to the cylindrical sheet of the Lenard tube, the metal cap bearing the aluminium window having been dispensed with as unnecessary. Exhaustion was carried on while the induction coil discharges passed through the tube until the sparks began to

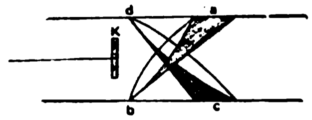


Fig. 4.

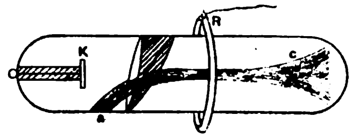


Fig. 5.

pass outside between the terminals E and E_1; then the apparatus was fused off the pump at s.

The connecting tube n served as a handle, being screwed into a wooden clamp. The fusing point s is the most endangered piece of the apparatus. On the approach of conductors sparks are easily produced here which puncture the glass. The ring R, which may be replaced by a thin annular wire, is placed at such a distance from K that the movable discharge is formed in the greatest intensity. Its appearance depends upon the distance between the conductors K and R. With high vacua it disappears completely when the ring R is

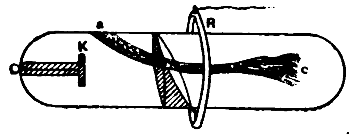


Fig. 6

brought very close to the plate, or is placed in such a position that K lies in the plane of R.

After having convinced ourselves that it was possible in this manner to prepare vacuum tubes which would constantly exhibit the phenomena, we next endeavored to determine the direction of the current in the movable thread of light. For this purpose we introduced such a tube between the poles of an electro-magnet provided with a commutator.

This information would be given by the behavior of the discharge in the magnetic field. For if K (Fig. 4) is a metallic plate from which cathode rays issue normally to the surface, these are not freely developed in a magnetic field; they are deflected like a current thread fastened at one end, and produce on the cylindrical glass wall a phosphorescent patch, which, according to the position of the commutator in the circuit, assumes the position a b or c d. The tube is supposed to be in an equatorial position.

In the first place, the ring R was placed so that the phenomenon shown in Fig. 2 took place; then the electro-magnet

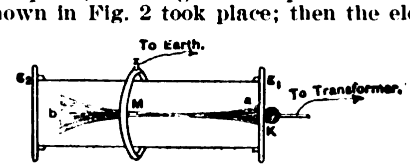


Fig. 7.

was excited. The result was that while the cathode rays proceeding from R were deflected upwards, the phosphorescent patch produced by the movable light thread shifted from the plate K down to the glass wall, or vice versa (See Figs. 5 and 6).

This implies that while the former are due to an electric motion proceeding from K as a cathode, the movable discharge must have its cathode at c, and that the two lengths represent the opposite phases of an electric oscillation. The mobility of the latter may, therefore, be due to the fact that the cathode is not a metallic equi-potential surface, but a plane, in either the glass or the gaseous space, whose position may be displaced by approaching conductors.

In the above experiments the discharges were introduced by means of a metallic electrode. Now we endeavored to simplify matters by using an electrodeless glass cylinder 5 cm. wide and 25 cm. long, the two ends of which were closed by plate

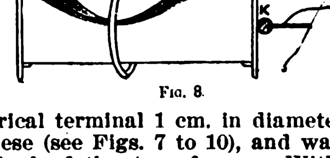


Fig. 8.

glass. A spherical terminal 1 cm. in diameter was in contact with one of these (see Figs. 7 to 10), and was connected with the free terminal of the transformer. With a suitable distance of the ring R from the electrode K, and with a suffi-

[1] *Wied. Annalen*, Vol. LVI., No. 12, p. 733.

[2] Movable light bands and brushes in a vacuum have already been investigated and described by Tesla (*see* Martin, "Tesla's Investigations," &c.), but we have considered the following short description of our experiments to be not superfluous on account of the simplicity of the arrangements, and the conclusion to be drawn from them concerning the nature of the movable discharge.—AUTHORS.

[3] *See* P. Lenard, *Wied. Ann.*, LI., Plate IV., Fig. 1.

[4] J. Tuma, *Wien. Ber.*, 102, Part 2A, p. 1,352, 1894.

ciently high vacuum (0.01 mm. to 0.001 mm. of mercury), there appeared, besides the phosphorencence of g_1, under the influence of the cathode rays proceeding from g_2, a bluish pencil of light at c (Fig. 7), which contracted in the center of the ring M to a narrow band, increasing slightly in diameter from M to a, and producing at a on the glass plate g_1 an intensely green phosphorescent circular patch of about 1 cm. diameter In this case, also, the luminous thread M a was highly sensitive to neighboring conductors. In the magnetic field it assumed, according to the position of the commutator in the circuit of the electro-magnet, the positions shown in Fig. 8

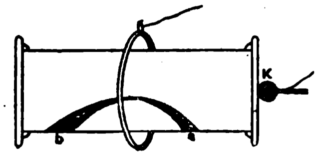


FIG. 9.

and Fig. 9. The phosphorescent spot is always designated by a.

We made sure, by a direct experiment upon a thin copper wire lightly suspended between the poles of the same electro-magnet, and traversed by a constant current, that this band of light behaves to magnetic forces as if it were traversed by a current from a to b. While, therefore, the cathode rays produced by K are directed from g_1 to g_2, as proved by the phosphorescence of g_2, as well as its behavior in the magnetic field, those produced in the movable band of light follow the reverse direction, from b to a.

Here, then, we obtain the same result as with tubes with flat metallic electrodes.

It might be argued that the movable phosphorescent patch is caused by the cathode rays proceeding from K, and reflected by the opposite wall. Although the behavior of the phenomenon in the magnetic field contradicts this view (in Figs. 5 and 6 the cathode rays proceeding from K do not reach the opposite wall at all), we thought better to decide this question definitely. We placed in the electrodeless vessel

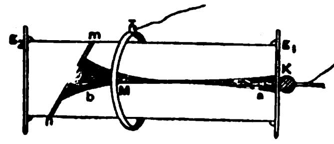


FIG. 10.

(Fig. 7), at an angle to the axis of the tube, an elliptical plane mica plate m n (Fig. 10), which would reflect the cathode rays proceeding from g_1 on to the wall of the cylinder. The discharge shown in Fig. 10 shows distinctly that the thread of light a b is not at right angles to the reflecting plane. The phosphorescent patch at a can, therefore, not be explained by the reflection of the cathode rays from g_1 at th mica plate.

Another conclusion also follows from this. Since cathode rays producing the phosphorescent patch a are not perpendicular to the mica plate m n (as is always the case when such cathode rays are formed at the surface of conductors or dielectrics), it may be assumed that their origin is not at the surface of contact between the mica and the rarefied gas. We are obliged to seek their origin in the gaseous space, and must consider that within the oscillating gas column the (as yet unknown) conditions are fulfilled which determine the genesis of the cathode rays. The gas column which is made luminous by rapid electric oscillations is therefore the origin of the cathode rays, and always produces phosphorescence when it impinges upon the glass wall of the tube. Since its position is entirely dependent upon the capacity conditions of the discharge tube regarded as a condenser—the discharge always going along that side of the tube which has the smallest capacity, and therefore first attains the discharge potential, this column and its cathode rays change with every change of capacity, as produced by the approach of conductors on one side. It always recedes from the conductor, since this increases the capacity on that side of the tube.

If the interpretation of the phenomenon described is correct it will give a further proof for the view of the nature of cathode rays founded by Hertz, Jaumann,[5] Lenard, E. Wiedemann, and Ebert, according to which these are not due to projected electrode matter, but to motions in the ether akin to light.

THE CHICAGO ARC LIGHT IMPROVEMENT COMPANY has been formed by P. Brown, W. G. Adams, and J. H. Miller, with a capital stock of $100,000.

[5] See the Paper, meanwhile published, on "Longitudinal Light," *Wien. Ber.*, 104, Part 2A, p. 747.

ON THE NEW KIND OF RADIATION.[1]

BY ARTHUR SCHUSTER, PH. D., F. R. S., LANGWORTHY PROFESSOR OF PHYSICS AND DIRECTOR OF THE PHYSICAL LABORATORY, THE OWENS COLLEGE, MANCHESTER.

PROFESSOR ROENTGEN, of Würzburg, announces the discovery of remarkable photographic effects, which he ascribes to a new kind of radiation. As the statements which have appeared in most of the daily papers are inaccurate in many respects a short description of what Professor Roentgen claims to have accomplished may interest the readers of the British Medical Journal. The photographs which the Professor has kindly sent me fully bear out his statements, and there can be no doubt that the most important discovery has been made.

It has long been known that the highly electrical particles which are projected from the negative pole of a vacuum tube produce a strong luminosity (phosphorescence) when they strike against the glass walls of the tube. Professor Roentgen's discovery is that, in addition to this phosphorescence, another radiation is produced, which is capable of penetrating through all bodies; though not to the same extent—thus, aluminum is more transparent to this radiation than Iceland spar. The radiation passes in straight lines easily through paper, cardboard, or wood, and produces photographic effects after having passed through two complete packs of cards.

Professor Roentgen shows a photograph, which has been taken in one room, the tube producing the radiation being in another room, the rays having passed through the door. One of the photographs in my possession shows a complete image of a compass needle, with the divisions into degrees of the circle over which the needle is placed. The compass needle, before being photographed, was placed inside a metal box. As flesh, skin and cartilage are more transparent than bone, the photograph of a hand gives a complete outline of the bones of the hand and fingers, the outlines of the flesh being only very faintly marked. It is not necessary to enter into the many possible medical applications which this photograph opens out.

One characteristic feature of this new radiation, which distinguishes it from all effects so far known of radiant light and heat, is that it cannot be refracted or reflected; that is to say, it will pass through a prism of aluminium having an angle of 60 degrees without being deviated from its original course. Hence lenses will not focus the rays, which will pass through a lens as they pass through an ordinary glass window. The photographs obtained are, therefore, of the nature of shadows, and their great sharpness is itself a testimony that the new radiation must be propagated in straight lines.

The radiation produces fluorescence as well as photographic effects.

Professor Roentgen does not give any information as to the length of exposure required, but any photographic plate or film seems to act. The photographs may be taken in ordinary daylight if the plate is kept in its dark slide, which will completely cut off all ordinary light rays and yet transmit the new radiation.

It is, of course, impossible to say what this new radiation will turn out. Professor Roentgen throws out the suggestion that it may consist of longitudinal vibrations in the ether. One's first impulse is to ascribe it to vibrations of extremely minute length. But, in any case, the fact that the velocity of its propagation is the same in vacuo, glass and aluminium will be a puzzle to mathematical physicists.

PHILADELPHIA EDISON CO.

The report of the directors of the above company for the year ending December 31, 1895, shows that during that period dividends were paid to the amount of $147,764, or 8 per cent., in quarterly payments on the stock capital of $1,847,000. The total profits of the year, deducting dividends, operating expenses and individual profits, amounted to $300,233.10, a net profit of 10 80-100 per cent. on the capital stock. The gross receipts of 1895 exceeded those of 1894 by $5,000; but the profits were reduced by extensive repairs undertaken last year, which placed the property in good order.

TREATING EAST BERLIN WELL.

The Berlin Iron Bridge Company has built an electric light system and will shortly light the whole town of East Berlin, Conn., by electricity free of charge. The company does this for the benefit and the protection of its big plant, as well as for the benefit of the town. The company has made application to the Southern New England Telephone Company for permission to run its wires on the poles of the telephone company, and it has been granted.

[1] "The British Medical Journal," Jan. 18, 1896.

WHO PROF. ROENTGEN IS.

Now that both Europe and America are stirred up over the recent photographic discoveries of Professor Roentgen, a few details as to that scientist will be of interest. He is of Dutch birth, and his full name is Wilhelm Conrad Roentgen. He studied in Zürich, where he issued a monograph on the way to establish the relations as to the warmth that exists in atmospheric air. When Professor Kundt left Zürich for Würzburg his favorite disciple, Roentgen, followed, and later again to Strasburg University, where Kundt and Roentgen held the same position as professor and assistant. In 1873 he taught at Strasburg; in 1875 he became professor of mathematics and physics in Würtemberg at the Agricultural Academy of Hohenheim. But 1876 saw him back in Strasburg at the university, and in 1879 he became professor and director of the University Institute for Physics at Giessen. He has been at Würzburg University since 1888. He has written various works, such as (1873) a method to fix the isothermal surfaces of crystals, and on the use of the ice calorimeter to determine the intensity of sunlight. Then he turned to electricity and studied the figures produced in dust by electrical discharges as Professor Kundt showed them, and the curious phenomena shown by electricity passing through various gases. The absorption of ordinary heat rays by steam and gases generally occupied him also. Many other studies in physics may be put to his account; a new aneroid barometer to tell the weight of the atmosphere is his invention. In acoustics he studied the sounds emitted when gases are intermittently lighted up; he also published an exposition of the theory and working of the telephone. His essays may be found in Poggendorff and Wiedemann's "Annalen," the "Zeitschrift für Kristallographie," the reports of the Vienna Academy of Sciences, of the Gesellschaft der Wissenschaften of Göttingen, as well as in those of the Gesellschaft für Natur and Heilkunde of Upper Hesse, and of the Physico-Medical Society of Würzburg.

Prof. W. C. Roentgen.

THE NEW PHOTHOGRAPHIC DISCOVERY.

BY PROF. SILVANUS P. THOMPSON.

A very singular scientific discovery has just been made by Prof. Roentgen, of Wurzburg. It depends on the transparency of materials to those kinds of radiation which are invisible to our eyes. For long it has been known, and it was a favorite point in the lectures of the late Prof. Tyndall, that the invisible waves of heat which are stopped by metals can penetrate through rock salt; and that the equally invisible actinic (or photographic) waves can penetrate through quartz, but are largely stopped by glass. Then Abney discovered means of photographing the heat waves, and succeeded in photographing, by its own invisible radiations in a dark room, a kettle full of boiling water. Later it was found that an opaque screen of the hard, black india rubber, known as ebonite is transparent to heat waves. Some seven years ago by the researches of Hertz and of Lodge, it became known that electric wages, though arrested by metallic screens, can pass readily through walls of stone, brick, or wood, or through the human body. Meantime, discovery had advanced in another direction. In Crookes' classical researches on electric discharges in high vacua, he discovered that in the extremely attenuated gaseous residues in the tubes which he employed, the discharges from the negative pole or kathode can cast shadows on the walls of the enclosing tube. These kathodic rays have been investigated by many experimenters, including Goldstein, Wiedemann, and Lanard. They were found to be curiously active in exciting phosphorescence, and to travel quite differently from ordinary rays of light. The lamented Prof. Hertz added to these discoveries the observation that these kathode rays, though incapable of passing through glass, would pass through thin sheets of metal, which would be quite opaque to ordinary light.

And now Roentgen has put a crowning touch to these facts by the remarkable discovery which has excited the Viennese press. He has succeeded in finding a means of photographing an object of metal, though it may be all the while shut up in a wooden case. A special source of light (a Cookes' tube stimulated by electric discharges) is placed behind, and the camera, or rather the sensitive sheet, in front of the wooden box. These special radiations pass through the box more readily than if it were of glass, but cast a photographic shadow of whatever metal object may be in the interior. This is scarcely photography, in the ordinary sense of the word. It is rather the photographic registration of shadows. Glass lenses cannot be used to concentrate these rays; hence they cannot be employed to form images. If a sheet of sensitive paper is in turn shut up in a wooden box, and an object of metal is placed in front, its shadow, as cast by the radiations from the Crookes' tube, is imprinted on the paper. No "exposure" (as the photographer understands it) is necessary. Indeed, the sheet of paper may be shut up in one box, and the metal object in another, and yet the photograph may be taken. In the same way Prof. Roentgen is able to photograph a man's skeleton through the skin, flesh, and clothes, which for this purpose are photographically transparent, while the bones are opaque like the metals. Placing his own outspread hand outside the closed box containing the sensitized sheet, he obtained a print of the finger bones and of the rings on the fingers. Whatever, then, the new kind of light may be that produces these effects, it differs both from ordinary light and from the ordinary photographic rays, as well as from the visible kathodic rays discovered by Crookes; for the latter pass through metal, but are stopped by non-metallic substances. Prof. Boltzmann, whose authority in physical optics stands undisputed, regards the discovery as of the utmost importance from the scientific standpoint; for it reveals the existence of phenomena not explained in any of the accepted theories of light or of electricity.

For the multitude the discovery is no less wonderful; it adds one more to the marvels of science. To photograph in total darkness seems inexplicable; but that we should be able to photograph through walls of wood, or through solid and opaque bodies, is little short of a miracle. We shall now be able to realize Dickens' fancy when he made Scrooge perceive through Marley's body the two brass buttons on the back of his coat. We shall now be able to discover photopraphically the position of a bullet in a man's body. Even stone walls will not a prison make to the revelations of the camera.—London "Saturday Review."

THE ROENTGEN RAY PHOTOGRAPHY.

BY PROF. EDWIN H. HALL.

Scientific men who have kept track of electrical investigations carried on in Germany during recent years are surprised more by the magnitude than by the character of the achievements now credited to Roentgen of Würzburg in the application of kathode rays to photography. According to the accounts published in newspapers—for no description of his work has yet reached this country through scientific journals—this experimenter has succeeded in photographing bones through the flesh of living limbs, coins through a leather envelope, and iron through the wall of a wooden box. Hertz, whose name is known to all the world, showed four years ago that the so-called kathode rays, generated by electrical discharges through a rarefied gas, would pass through metal films impervious to ordinary light, and produce optical effects beyond. Lenard of Bonn, succeeded Hertz in this particular line of investigation, and has been until now the chief authority as to the penetrative power of these rays. In "Wiedemann's Annalen" for October, 1895, he has an article, the opening paragraph of which ber, 1895, he has an article, the opening paragraph of which will show the point which his experiments had reached at the time he wrote, and will explain why scientific men in this country were not prepared for the announcement of Roentgen's brilliant work. Lenard says in substance:

"Since it has been shown that certain metals are permeable by kathode rays, it is now in order to test the permeability of other materials. It appears that not metals alone, but all kinds of solids are permeable, though all in only very thin, delicate sheets. No solid body has been found to act toward kathode rays as glass acts toward light. Gaseous bodies are much more permeable than solids, and may be penetrated for centimeters."

He goes on to say that, having tried many solid and gaseous bodies, he is led to the conclusion that the permeability of a

body is pretty nearly proportional to its density (or specific gravity), without much regard to the state of aggregation or to the material of the body. For instance, he gives:

	Absorptive Power.	Density.	Absorptive Power / Density.
Air	3.42	.00123	2780
Collodion film........	3310	1.10	3010
Paper	2690	1.30	2070
Aluminum	7150	2.70	2650
Gold	55600	19.3	2880

Absorptive power is the opposite of permeability.

Apparently his experiments were limited, in the case of solid bodies, to sheets a few thousandths of an inch in thickness, although sheets somewhat thicker would have been permeable to a certain extent. He has shown, however, that the behavior of kathode rays varies somewhat with the manner or circumstances of their production, and it is quite possible that Roentgen has hit upon a much more powerful method of producing them than Lenard used. Hence, though it is well to wait for fuller details before accepting in full the remarkable stories of Roentgen's work, it would be rash to deny the possibility of their truth. Meanwhile a brief explanation of the terms used in connection with his work may be of interest.

Faraday, studying the galvanic cell some sixty years ago, felt the need of definite short names for the conductors by which the current of electricity, to use the common phrases, enters and leaves the cell. Faraday's education, like that of Edison, was not obtained at school, and he knew no Greek, but a learned friend furnished him with the term "anode" (upward way) for the conductor taking the current into the cell, and "kathode" (downward way) for that leading the current out from the cell. The two together were called electrodes.

A few years later Faraday studied the discharge of electricity from one piece of metal to another across a space containing rarefied air within a glass vessel. The pieces of metal leading the current in and out are called, as in the galvanic cell, the anode and the kathode respectively, and Faraday observed, as others had done, that the spark or brush or glow occurring within the tube during the passage of electricity was not of the same appearance at the two electrodes. He studied the phenomena with care, and suggested that the difference observed was due to a difference in the state of polarity or electric charge of the gas in the neighborhood of the two electrodes. This suggestion is by no means out of date, although it can hardly be said that this or any other theory of the matter has been generally accepted as satisfactory.

After Faraday came certain German experimenters, who made a special study of similar effects. Geissler made such advances in the apparatus used for showing electric discharge in rarefied air, substituting permanently sealed tubes with platinum electrodes for the comparatively clumsy and inconvenient apparatus of his predecessors, that the term "Geissler tube" soon became familiar in scientific literature. Geissler's improvements in the air pump enabled him to carry the rarefaction of the air to a high degree. The current is usually driven through the tubes by a Ruhmkorff induction coil, which furnishes a rapidly interrupted current. Ingenuity and mechanical skill were lavished upon the production of new forms and varieties of Geissler tubes, containing rarefied air, oxygen, hydrogen, etc., each showing its peculiar kinds of light, all of them beautiful and most of them inexplicable.

But in all, or nearly all, of them the kathode during action was surrounded by a narrow, colorless, or dark space outside, which was a glow of blue or violet light. The space around the anode and the greater part of the whole tube were also generally luminous, but in a different and far less clearly defined manner. It was evident, too, that more heat was generated at or near the kathode than elsewhere in the tube. The kathode, therefore, became the center of interest.

It was a common thing to use in the construction of Geissler tubes a kind of glass, called uranium glass, which has the peculiarity of giving out a greenish light when exposed to rays of light containing no green whatever. This kind of effect, which is shown in some form by various other substances, fluorspar, for instance, is called fluorescence. It was observed that the influence, whatever it might be, that especially produced fluorescence in Geissler tubes came from the kathode. It was observed, too, that this influence in very highly rarefied tubes appeared to come along straight lines from the kathode, and so the term "kathode rays" came into use, being suggested, of course, by the term light rays, although it was by no means certain that the kathode rays were rays of light.

Indeed, William Crookes, a distinguished English chemist, the inventor of the beautiful and interesting scientific toy called the radiometer or light mill, advanced the opinion that the so-called kathode rays were particles of matter, in what he called the "ultra gaseous" state, projected in straight lines from the kathode upon neighboring parts of the apparatus. Crookes, who is a man of great experimental resources, devised new forms of apparatus of such extraordinary interest that the term Crookes tube has now in great measure replaced the term Geissler tube.

But though the light generated in a rarefied gas, or in a fluorescent substance within the tube, by means of the kathode rays could readily be seen through the wall of the tube, it was observed that uranium glass placed near the kathode but outside the tube was not affected. That is, the kathode rays themselves, whatever they might be, could not pass through the thin glass wall of the vacuum tube. This was the condition of affairs when Hertz showed the kathode rays to have the power of passing through thin sheets of metal placed inside the vacuum tube. The next step, taken by Lenard, was to replace a very small part of the glass wall of the tube by a very thin piece of aluminum. This little spot of aluminum set in a glass wall he called a window, and through this window, which ordinary light could not traverse, the kathode rays which could not penetrate the glass went out into the open air, which they penetrated to a distance of about three inches, spreading out in all directions from the window as a center. They passed through the window in preference to the glass merely because the metal was thinner than the glass. Their presence in the air was shown by the faint glow of the air itself, by photographic effects, and by fluorescent effects like those already described, but neither the skin nor the eye exposed directly to the rays after they had passed the window gave any sensation.

If the kathode rays are light rays, they are apparently of the sort called ultra-violet, rays, which in passing through a prism are refracted more than the violet rays of ordinary sunlight. It is well known that such rays exist, and that they are effective in photography, though our eyes are incapable of getting any sensation directly from them. It need not surprise us to find that there are ultra-violet rays which do not readily penetrate glass, as there are other well-known rays which do not penetrate glass. The surprising characteristic of kathode rays, as Lenard has found them, is the uniform difficulty they have in passing through bodies of different materials. Apparently Roentgen finds much less uniformity in this particular.

Lenard seems to consider kathode rays as of the same nature with common light rays, but of much shorter wave length. He compares the obstruction they meet in passing through air with the obstruction ordinary light has in passing through a space partially filled with particles of a sensible size, dust particles, for instance. A serious objection to this view is the fact, recorded by Lenard himself, is that kathode rays are apparently deflected by a magnet, somewhat as a current of electricity is deflected, whereas common light, though yielding in some ways to magnetic influence, is not so affected. —New York Sun.

PHOTOGRAPHY OF THE INVISIBLE WITHOUT THE AID OF A BROOKES TUBE.

BY

William James Morton, M.D.

UPON reading about the results obtained by Professor Roentgen with the cathodic rays of Crookes' tubes, it occurred to me that possibly the same or similar results might be secured by the ordinary and familiar electric radiations from influence machines and induction coils. May not such radiations, whether invisible of partially visible, produce the effect thus far claimed to be peculiar to the "X rays" at the cathode of the Crookes' tube? Some recent experiments which I have made would seem to prove that the above view is correct.

I submit a few experiments for what they are worth. They would seem to demonstrate that objects, enclosed and invisible, when interposed in the pathway of ordinary electric radiations, may be photographed upon relatively distant sensitive plates by reason of variations in the strength or quality of the radiations produced by the interposed objects.

The well-known images produced by a coin or other metal object laid directly upon a sensitive film and electrified are not here referred to, since in my experiments the interposed metal was separated from the film by several thicknesses of heavy cardboard or of wood one-quarter of an inch in thickness, in this respect exactly repeating the experiment of photographing coins within a purse or a box. I have obtained two classes of results:

(a) The interposed and invisible metallic object produces a black image of itself upon the sensitive plate.

(b) The same object produces a white image of itself, showing that it has entirely intercepted the rays.

This statement refers to the effect produced upon the sensitive plate. A print, of course, would exhibit in the former class white and in the latter class black images. The latter only corresponds to the photographic "picture" which I understand to be produced by the cathodic rays of a Crookes' tube and which may be termed a cathodograph. (Query: Is not the print exhibiting white images an anodograph?)

Experiment 1., Fig. 1.—A sensitive film was placed inside of an ordinary film holder or box commonly used to pro-

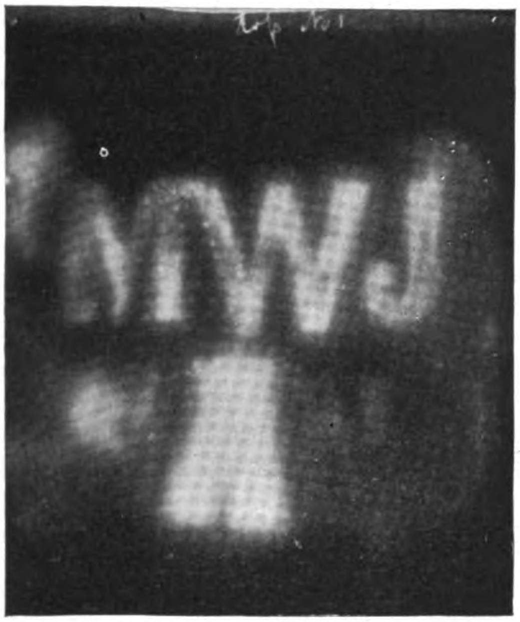


FIG. 2.

tect it from light before exposure in the camera. This box consists of wood and blackened cardboard slides. Upon the outside of the box was laid the letters C O P, cut out of a very thin sheet of pure copper. Upon the letters was laid another sheet of cardboard of the same size as the box, namely, 4x5 inches, the whole securely clamped by strong rubber

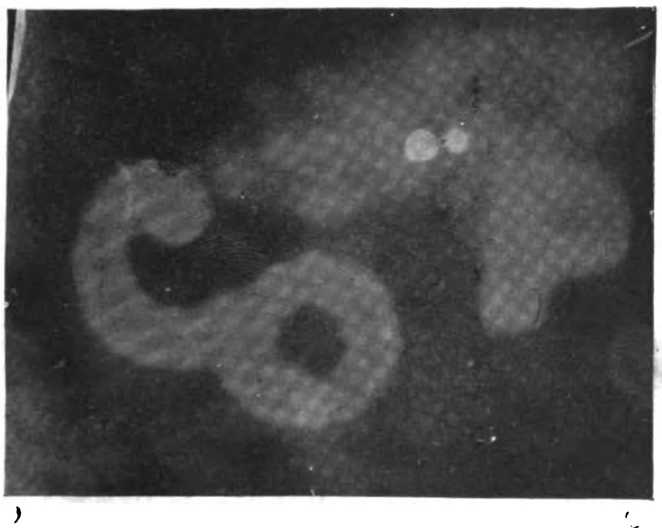


FIG. 1.

bands. An influence machine was then set in action with the following adjustment. To avoid sparks no Leyden jars were used. The negative discharging rod was the ordinary brass ball, one inch in diameter, the positive a sharp point, the two separated about six inches and the prepared box placed in the intervening field in such a manner that it laid against the negative ball. The characteristic "fox tail" or brush discharge from the positive point extended nearly to the box; no spark appeared at the negative pole or elsewhere. After five minutes' exposure in this field the film was developed, and presented the appearance represented in Fig. 1. (The letter O had slipped out of line.)

This experiment has since been repeated much more satisfactorily and in every instance produces a black image of letters or of coins upon the film.

Experiment II., Fig. 2.—Film holder arranged as in proceeding experiment, except that other copper letters cut from the same sheet were substituted and covered with additional layers of cardboard. The box and wood thus prepared was held for five minutes between the poles of the secondary circuit of a "high tension" induction coil, whose primary current was an oscillating Leyden jar and spark gap current. The distance apart of the two sharp pointed terminals was about three inches, and only a slight visible brush discharge appeared at these terminals. Upon developing the film the letters appeared outlined as represented in Fig. 2—namely, M, W, J and A.

Experiment III., Fig. 3: A "cathodograph."—The influence machine was arranged substantially as described in Experiment I. The copper letters were loosely laid upon the outside of the box containing the sensitive film and retained in place by other pieces of cardboard laid upon them and clamped by strong rubber bands, thus fulfilling every condition of an invisible object. Exposure to the influence of the radiation was five minutes. Upon developing the film, the letters, instead of appearing black, were now white, while the remaining portions of the film were black. The print exhibits the black letters W. J. M., Jan. 30, '96.

This result would seem to indicate that the copper letters had intercepted the radiations. The outlines, it is true, are not as clear cut as could be desired, but this no doubt is accounted for by the varying texture of the enclosing envelope, which was far from homogeneous. I have also obtained other "cathodographs." In conclusion, experiments I have thus far made, including many not detailed here, lead me to believe that cathodic rays capable of producing some of the effects described by Professor Roentgen are not confined in their production alone to high vacuum tubes, but may be detected, under proper management, in connection with ordinary electrical exciters.

PERSONAL.

MR. E. W. LITTLE has resigned from the managership of the Interior Conduit and Insulation Co., and informs us that he will not hereafter be connected in any way with that concern. While Mr. Little is reticent as to his plans for the

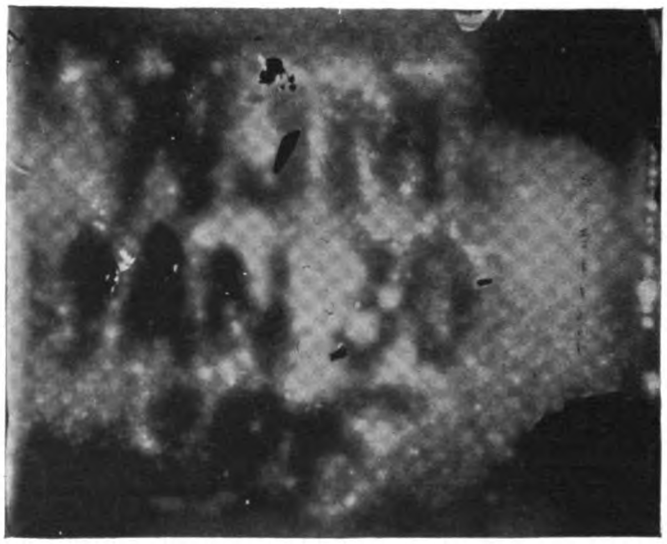


FIG. 3.

future, it may be safely assumed that he will engage in some other electrical enterprise, where his long experience in the general field will prove of great value. Mr. Little has among other things, seen the interior conduit business evolve from nothing into a great and growing industry, and has taken a very active share in the work.

MR. E. H. FOERST, of San Francisco, who has been in New York on business for the past five or six weeks, has returned to the coast, after securing for his company many valuable agencies. Mr. Foerst has been a familiar figure in the electrical center of Cortlandt Street, and he will be much missed, as he has made many friends for himself while East.

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CATHODOGRAPHS AND PHOSPHOTOGRAPH.

THE remarkable, not to say sensational, effects obtained by Prof. Roentgen in securing cathodographic impressions on a photographic plate of objects screened from light rays, has set experimenters and investigators to work the world over, and results are beginning to be recorded from many quarters. American physicists, we are glad to know, have not been found lagging in their efforts to take up and carry further the work begun so auspiciously, and we are glad to be able to place before our readers in this issue a reproducion of fine cathodographs secured by Prof. A. W. Wright, of the Sloane Physical Laboratory of Yale University. A contemplation of this print, which must of necessity lack some of the sharpness of detail possessed by the original plate, cannot fail to impress the reader with the marvellous result achieved in this new field. One can as yet barely speculate on the paths opened up not only for the direct application of the discovery, but for the clue it may give to a further elucidation of the properties of the ether, and correlatively with that, of the multitude of phenomena directly involving the action of the ether. Like most discoveries of this nature, it may, at least in part, be traced back to the ideas and facts set forth by previous experimenters. In the present instance the work of Hertz and of his disciple and successor, Lenard, without doubt contributed largely to guide Prof. Roentgen in his great achievement, but no one will on that account begrudge the credit due him as the first one to obtain these novel results. An interesting contribution to the subject under discussion is that by Prof. Elihu Thomson, which we print elsewhere in this issue. With the true faculty of the inventor always active, Prof. Thomson suggests a novel method of constructing a cathode ray generator. While thus far results had only been attained with Crookes' tubes it seemed not improbable that effects of a similar nature might be attained without the employment of highly vacuous enclosures; indeed this opinion is shared by not a few and has been experimentally tried by Dr. W. J. Morton, of this city. Some of the results thus far attained with this method by Dr. Morton have been placed in our hands by that eminent electro-therapeutist, and are illustrated in this issue. They present certain peculiarities which will no doubt give rise to further discussion.

A substantiation of the contention that the Crookes tube is not necessary to obtain the desired effects is also found in the strange announcement which reaches us as we go to press, that M. Lebon, in France, has succeeded in affecting screened sensitive photographic plates by the rays emanating from an ordinary oil lamp. If this experiment should be confirmed, and it would require very little time and trouble to do so, it seems not unreasonable to believe that like results can be obtained with ordinary sunlight. We may also note that Prof. Dolbear claims to have obtained photographic prints of screened objects by the aid of radiations from a static electrical machine. In the mean time the de-

mand for Crookes' tubes has, we understand, created a "corner" in that commodity.

While devoting space to the presentation of the subject we have deemed it well to bring out in contrast to it the most recent development in actual photography by the aid of the vacuum tube light. Mr. D. McFarlan Moore, of the progress of whose work we have made note from time to time, has made rapd strides in the improvement of his aparatus, and no better proof of the advanced ground occupied by this young inventor could be submitted than the reproduction of the photograph which forms the subject of the supplement to this week's issue of "The Electrical Engineer." What this picture means can perhaps only be fully realized by those who have themselves worked in the field of vacuum tube lighting or have witnessed experiments in it. The volume and intensity of the light indicated by this picture are far beyond anything of this nature which has before come under our notice, and the simplicity of the apparatus by which it is produced seems to us one of the strongest arguments for its claims to a practical solution of the long sought for "light without heat."

ELECTRICITY IN WARFARE.

NOT a few of our American and English contemporaries, electrical or otherwise, have recently devoted considerable space to the plans suggested by Mr. Edison for the defense of this country should it be unfortunate enough to have to go to war, all of a sudden, over some question of fish lines, boundary lines or poetical lines—for, in reality, the appointment of Mr. Austin as poet laureate of the English speaking peoples seems to us a more serious casus belli than any other now before the public. We have read with deep interest all that Mr. Edison has had to say on the vital subject of coast defense, and must confess we can find in it nothing more than the shrewd, ingenious and noteworthy suggestions of a true-born Yankee inventor. Mr. Edison deplores the bare mention of wanton bloodshed, but intimates that if we had to protect ourselves in a hurry, there are various electrical novelties which might count.

To a certain extent, these amiable discussions are like those which flighty young ladies indulge in when they ask what each other would do if there were actually a burglar under the bed; but they have a practical side. They serve first of all to call attention to the wretched state of unpreparedness in which the nation allows its its necessary defense to linger. After all, no man is imprudent or bellicose because he takes out a fire insurance policy or maintains a fire brigade; and in that light military and naval defense must ever be regarded. But lacking a policy of readiness, the patriotic inventor is not to be scorned for suggesting buckets of sand or hand grenades in an emergency. Mr. Edison has hinted at many possibilities of electricity, and at some things which are more than possibilities. Perhaps only a war could determine whether he is wholly right or utterly wrong. It is one of the very few compensations of war that it helps perfect ideas and inventions which in the long run are of great value in the arts of peace.

The most sober and effective critic of Mr. Edison is Lieut. B. A. Fiske, himself no mean electrician or inventor, but his quoted remarks sum up into the highly practical point that no matter how good some of these Edisonian novelties might be, men are needed who have been drilled and trained to handle them. Probably Mr. Edison would be the first to accept this sensible dictum, but no inventor stops producing because a corps of experts has not been trained in advance to manipulate his latest devices before they come out. By all means let us have some more skilled electricians in the army and navy, more expert balloonists, more torpedo and submarine navigators; and do not let us sneer at or be afraid of trying the new ideas that the innovating Armstrongs, Nordenfeldts, Maxims, Ericssons and Edisons venture to offer, not as substitutes for a respectable army or navy, but as fitting auxiliary tools and weapons for a modern arm of defense. Congress might do much worse than save a little money from other appropriations for the trial of such devices.

FUSE VS. MAGNETIC CUT-OUT.

THE permanence of an art, let alone its progress, must depend largely on the reliability of the apparatus employed in it, and in this term must be included the factor of safety. From the very first, the fire hazard connected with current distribution has been forced upon the electrical engineer, and indeed its consideration still constitutes a live question before electrical bodies towards which the constant pressure brought upon them by the fire underwriters has contributed not a little. The fusible cut-out has long been the subject of special attacks, but one of the strongest indictments thus far formulated against its use is the report of Mr. Wm. McDevitt, of the Philadelphia Board of Fire Underwriters. In view of the probable effects of the submission of this report we have deemed it well to print it in full in order to place before our readers all the evidence adduced by its author in his sweeping condemnation. That Mr. McDevitt does not stand alone in the position taken by him no one who is familiar with the drift of opinion in electrical circles will deny, and the increasing number of specifications calling for magnetic circuit breakers for circuits carrying above 15 or 20 amperes strongly supports Mr. McDevitt in his contention. The fuse has done good service, but if its day of usefulness is gone for heavy currents, then it must give place to its old competitor, even though its low cost is not the least of the arguments in its favor.

This week "The Electrical Engineer" appears in a new dress of type, which it believes to be in many respects more handsome than its recent garb of type. It trusts that the change will be accepted as another proof of the intention of the paper to give its readers the best.

TELEPHONY AND TELEGRAPHY.

THE HUMBLE BEGINNING OF THE WESTERN UNION

In some recent reminiscences, Mr. W. B. Levet, of Rochester, N. Y., says:

The writer first entered the service of the Western Union Telegraph Company in 1857 as clerk in the office of Isaac R. Elwood, the first secretary and treasurer of the company, a man whose integrity was never questioned, and whose conservative policy in connection with the operation of the company in those early days inspired confidence in it among the business men, which had much to do with its ultimate success. I was introduced to Mr. Elwood by Judge Robert Wilson (known as "Bob" Wilson, of Mexican fame) and remained with the company until its removal to New York in 1866. At that time the secretary and treasurer's office occupied only the first room over what is now the Bank of Monroe. All the financial and executive business of the company at that time was transacted in that one room by Mr. Elwood, F. G. Ritso, bookkeeper, and myself as clerk. Subsequently the president, Hiram Sibley, occupied one of the back rooms as an office, and later the two back rooms were thrown into one and used for a directors' room and a large fire proof safe was procured. I well remember making out the list of stockholders and the amount held by each for the first dividend, which, if my memory serves me aright, was 20 per cent. cash and 16 per cent. stock, the total capital thus increased being $116,000. These dividends were soon followed by other and larger ones of both kinds.

Besides the gentlemen you mention who were associated with Mr. Sibley in the undertaking were Ezra Cornell, of Ithaca, father of the ex-Governor, who was the prime manipulator of the Erie and Michigan Telegraph Company, which was really the basis of the Western Union. In after years a share of the original stock of that company was worth a small fortune. Henry S. Potter and Joseph Medbery, of Rochester, Joseph H. Wade, of Cleveland, and Anson Stager, of Ashtabula, and many of the prominent citizens of Rochester were afterwards auded to the directors and the business rapidly increased.

Before the Russian Extension Company, the overland line to the Pacific coast, was built, special stock being subscribed, for that route was accomplished under very serious difficulties. In many instances he had to rely on the "Pony Express," which then carried the mail to the Pacific coast, as his escort and only guide. That line, built under almost insurmountable obstacles and which was the forerunner of the Pacific Railroad, proved to be a bonanza both for the contractor and the stockholder. A good deal of the present wealth of Rochester may be traced to the investments therein made, while Cornell University at Ithaca, Sibley Hall on our own campus, Wade Park at Cleveland and Creighton College of Omaha, each bearing the name of its generous donor, are to be traced to the large fortunes made from this venture. All honor to these men for their generosity to their fellow citizens. All of them are, I believe, dead, but by these acts they still speak. I remember well one time when the receipts of the California office were sent to the treasurer's office here in gold coin, and the clerks who counted it were requested by Don Alonzo Watson, in a quaint way he sometimes had, to save the water when we washed our hands, as it would be a capital thing to "water the stock" with.

Excitement ran high in those days, and Rochester has never seen such times since. The efforts and strategy employed to secure stock when it was increasing in value every hour, and fabulous values were attribute to it, will never be forgotten by those who saw it from within. When it was hinted or surmised that a dividend was to be declared, investors and speculators were wild to possess it, and the transfer books were kept hot for days before they were closed. Many of the most valuable parcels of real estate in this city were purchased with this stock at greatly inflated values.

When the Russian extension line was projected, which was not until after the first Atlantic cable failed, Samuel Wilder, one of the directors, was dispatched to New York as purchasing agent for the necessary supplies for that project, and after long and laborious effort on his part, when the good ship Milton Badger (the first of three vessels sent) was loaded and sailed from that port to Behring Strait it was supposed that the initial step had been taken for the production of another rich harvest. but, alas; after the expenditure of many hundred thousands of dollars and before the Badger reached the straits, Cyrus Field, by his indomitable perseverance, had laid the second Atlantic cable. which proved successful, and the Russian extension was an immense failure, and probably many of the poles intended for other purposes have served distinguished families among the aborigines as totems, while the axes, shovels, wagons, insulators and other implements have been used for other purposes by the natives, and the beads and other trinkets have undoubtedly adorned many a Russian beauty who then inhabited those bleak regions.

For many years Rochester was in various ways benefited during the company's life here. Among other things the "Evening Express" Company, I remember, had a contract to supply all their printing, so that all the blanks, envelopes and other stationery were supplied by the company to all the offices throughout the country.

TELEGRAMS A "PRIVILEGED COMMUNICATION."

The recent decision of Chancellor Sneed, of Tennessee, that telegraphic dispatches are privileged communications, and that their secrecy may not be violated by the courts except in the most extraordinary emergencies, was based not alone upon the law of the State that telegraphic messages are confidential, but also upon abstract reasoning, from the standpoint of common law. Not the least of the obligations indispensable to the efficient operation of the telegraph as a commercial agent, the Chancellor said, is the confidential relation between the agencies of the telegraph and its customers. There is no instrumentality in public or private business which the people have to draw more closely into their confidence. To rule, as courts have done, the Chancellor continues, that agents of a telegraph company might at any time be called into court to betray matters which came to their knowledge in the transaction of their business, is a "violation not only of public policy, but of the rules of right and the implied contract of the parties. Aside from the positive legal restriction, it would seem that the usefulness of the telegraph as a commercial agent would be irretrievably impaired by the practice referred to, as the most important correspondence between the commercial man and his agent, a correspondence on which fortunes may depend, is often carried on through the telegraph, in which the most delicate questions are sometimes in good faith asked and answered, and in which other men's affairs are brought into question in a manner that might lead to trouble or litigation when no harm was intended. It would seem just as reasonable to establish a judicial espionage over the mails and to compel the postmaster to surrender or break open letters and reveal the secrets of all or any private correspondence that may come into his possession."

FOR A PACIFIC CABLE.

At a conference of the Postmaster General of the Australian Colonies, in Sydney, N. S. W., Duncan Giles and Sir Saul Samuel, Agents General in London of Victoria and New South Wales, respectively, were appointed Australian delegates on the Pacific Cable Commission. The conference adopted a resolution declaring that Great Britain, Australia and Canada should each pay one-third of the cost of the cable; that the landing places should only be on British territory, and that the route from Fiji should be to Norfolk Island, from which place the line should go to North Island, New Zealand, and to Moreton Bay, on the east cost of Australia.

LETTERS TO THE EDITOR.

HERE'S ANOTHER PHOTOGHAPHIC SUGGESTION.

Having been greatly impressed by a passage in Tom Hood, which I came across not long ago, I judge your readers may be likewise interested, and I accordingly inclose herewith. The application is obvious. G. H. STOCKBRIDGE.

New York City.

Here is the passage: "But in this century of invention, when a self-acting drawing paper has been discovered for copying visible objects, who knows but that a future Niepce, or Daguerre, or Herschel, or Fox Talbot, may find out some sort of Boswellish writing paper to repeat it whatever it hears!"

AN EARNEST OF PROGRESS.

Your issue of January 8th is an earnest of progress and stability. It not only says, "We are here," but "Come along."

P. B. DELANY.

IT MAKES ONE'S MOUTH WATER

It gives me great pleasure to testify to the pleasure I have already had in reading the very complete and admirable article, in your issue of January 8th, upon the New York electric lighting stations. It makes one's mouth water, so to speak, in the way of wishing to also be an electric light maker, with a good enough plant to be so well written up.

OBERLIN SMITH.

MISCELLANEOUS.

THE GROSS UNTRUSTWORTHINESS OF FUSE METALS AND APPLIANCES AS A MEANS OF PROTECTION FOR ELECTRIC CIRCUITS.—THE REMEDY.[1]

BY WM. MCDEVITT, INSPECTOR, PHILADELPHIA BOARD OF FIRE UNDERWRITERS.

IN all the strides for improvement in electrical devices there is none which has received as little attention, when considering its importance, as that of fuses and their appliances.

In the first attempts in the application of fuses and fuse blocks, great trouble was experienced, owing to use of wood for blocks, too short space between terminals, arcing, heating from insufficient carrying of screws and terminals. Troubles of a serious character manifested themselves, due to the above defeats, resulting in burning or charring of wood, loosening of contacts, and, in many instances, the total destruction of the entire fuse block. Porcelain was finally adopted as the means for overcoming the objections inherent in the older wood fuse block.

The old troubles still continued, and changes have been made from time to time in the terminals, screws, distances between terminals, etc.

For several years back instances have occurred to my knowledge where the line, although properly fused, has been seen to give off smoke, followed by the virtual roasting and destruction of the insulation. Investigation proved that this was due solely to the sluggish action of the fuse when the circuit was either overloaded or short-circuited.

Alloys of different compositions have been used. Experience has proven that some chemical change takes place, either from oxidation or action of the current, resulting in variation in fusing current required. In some instances, to my knowledge, the fuse blowing far below its rated capacity, thus made a temptation for users to fuse higher than good judgment would dictate

Owing to the repeated cases in my experience, such as burned-out fuse blocks, charred insulation on wires, burned gas pipes, etc., the grave fire risks attendant upon the use of fuses and fuse blocks, has continually obtruded itself upon me, and has led me to examine into the subject of fuses and their appliances very carefully.

The gross unreliability of fuse metals, and the lack of dependence to be placed upon the best designed fuse blocks used in practice, has forced me to the opinion, that in all cases of over 10 amperes capacity, fuses and their appliances, while generally operating as desired, under certain conditions, however, are a serious fire risk, not only in themselves, but in their failure also as a protector. As some criticisms have been made concerning my opinions for some time past, the following tests and quotations from authorities upon fuse metals are herewith given to emphasize the claims of the writer as to the gross unreliability of fuse metals, and the fire risks attendant upon their use in all cases over 10 amperes' capacity. Further, the tests show the lack of dependence to be placed upon the fuse blocks used in practice.

The following tests were made in Philadelphia, January 14, 1896, across the terminals of a 100-light, 110-volt dynamo. A Weston ammeter, a water rheostat, a main switch, and the fuse blocks were all in series. A short circuiting switch around the fuse was used in most instances, permitting the current adjustment with water. rheostat before throwing current upon the fuse to be tested. In many instances commercial fuse blocks and standard fuse metals were employed.

No. 1.—Standard 30 amperes. D. P. Cut-out, strip fuse, main line, five-light standard link fuse, 3½ amperes. The dynamo magnetic circuit breaker set at 25¾ amperes. Current of 26½ amperes passed through fuse and breaker five consecutive times, and protecting fuse; fifth time blew fuse, but did not open breaker.

No. 2—.Five light fuse, 3½ amperes. Blew at 26 amperes.

No. 3.—Five light fuse or 3½ amperes. Ten to twelve tests on fuse without blowing with current of 27 amperes every time. After this 15 amperes was run through same fuse for 1½ minutes, heated fuse slightly but did not blow. Then same fuse carried 30 amperes, for 9 seconds, became red hot before blowing.

No. 4.—Ten-light standard link fuse, 7 amperes. Held 15 amperes for 30 seconds, became red hot, and blew.

No. 5.—Ten-light standard link fuse, 7 amperes. Carried 14½ amperes 3 minutes and 10 seconds. Maintained red heat 2 minutes of that time before blowing.

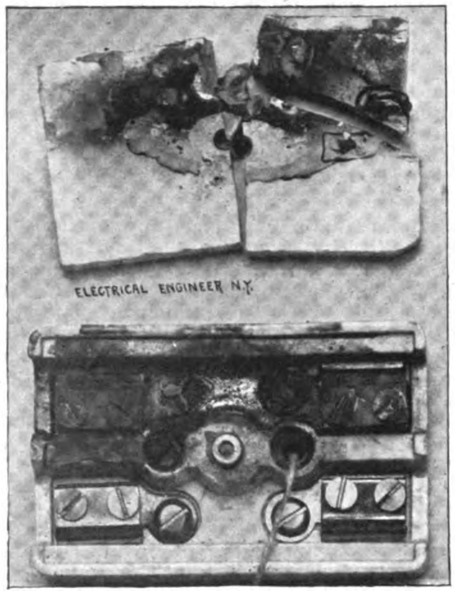


EXHIBIT WITH TEST NO. 19.

No. 6.—Fifteen light standard link fuse, 10½ amperes. Circuit breaker, 46½ amperes. Opened six times without perceptible change in fuse. Then this fuse carried 30 amperes 28 seconds.

No. 7.—Fifteen-light standard links, 10½ amperes. Circuit breaker set at 46½ amperes. The fuse carried 40 amperes 5 seconds, became red hot before blowing.

No. 8.—Twenty-light standard links, 14 amperes. Carried 40 amperes 18 seconds, white flame, arced for some time before breaking circuit.

No. 9.—Twenty-light standard link, 14 amperes. Fuse block covered with mica. Carried 40 amperes 18 seconds; heated, burned mica badly before blowing.

No. 10.—Twenty-light standard links. Block covered with mica. Carried 40 amperes; mica burned about half way through; time 22 seconds

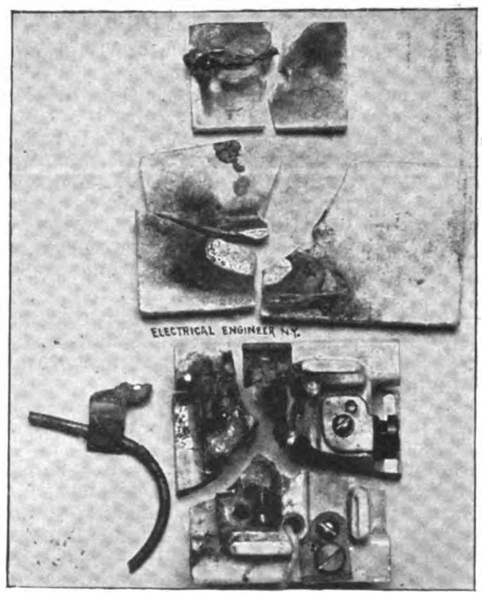


EXHIBIT WITH TEST NO. 23.

No. 11.—Twenty-light standard links. Same as before. Current 40 amperes; time 32 seconds. Burned mica still further.

No. 12.—Thirty-light standard link fuse; 21 amperes. Covered with fresh mica. Main circuit breaker, after 50 seconds, carried current from 40-43 amperes Fuse showed dull red before blowing.

[1] Report submitted to the Philadelphia Board of Fire Underwriters.

No. 13.—Same fuse, 21 amperes, as before. Mica covering new anl clean, carried current of 45 amperes 55 seconds; damaged base.

The standard block replaced with 25 amperes. Branch block marked (A)

No. 14.—Fuse, 15 amperes, standard fuse. Carried 40 amperes 1 minute; then arced for at least 10 seconds The block was lying on back

No. 15.—Fuse, 15 amperes, standard fuse. Block vertical, lying lengthwise. Carried 40 amperes 28 seconds; then fused and arced 32 seconds. Cracked lid, composition ran out back. Block cracked from heat. Vicious, continued arcing. Destroyed the block A.

No. 16.—Standard main line 25, lying lengthwise. Fuse (15 amperes), edge of block forming a shelf for fuse and covered. Current carried 40 amperes 2 minutes; 45 amperes 1 minute. Showed only slight variation in color. Current withdrawn.

No. 17.—Same fuse, 15 ampere, standard; 1 minute carried 40 amperes; next minute 45 amperes; slight change in color. In this test the block was turned on short end. Edge of block forming a shelf for fuse, as before, and horizontal. Current withdrawn.

No. 18.—Block uncovered. Same fuse, 15 amperes, not touching block. Carried 40 amperes 35 seconds and blew. Block standing on short end, fuse vertical.

No. 19.—Fifteen ampere fuse, standard, same block. Covered, lying on back in proper position, as on ceiling. Fuse touched lid. Carried 45 amperes for 20 seconds; then arced with 27 amperes 33 seconds, producing exhibit No. 2, Burned seriously, vicious, continued arcing; destroyed the block. (See Exhibit.)

No. 20.—Standard main line D. P.; thirty-light link, standard fuse; 21 amperes; block face (mica) down. Carried 40 amperes 1 minute; 45 amperes for the next 50 seconds. Blew against mica.

No. 21.—Same block, fuse, and position as No. 20; 45 amperes 22 seconds. Blew with small arc against mica.

No. 22.—Same block and position, against mica; 15 amperes standard. Carried 45 amperes. Blew in 17 seconds.

No. 23.—Ten amperes, branch block marked exhibit No. 3; 10 amperes standard fuse. Stood on its side, fuse horizontal, cover on, carried 35 amperes, and blew in 5 seconds. Arced for 35 seconds. Current in arc dropped from 28 to 18 amperes, arching vicious. Block destroyed. (See Exhibit.)

No. 24.—No. 2,165 standard plug. Block face down; 3 wire main line, 30 amperes, ten-light plug. Carried 20 amperes 5 seconds; actual carring capacity of fuse 3½ amperes. Practically 500 per cent. overload.

No. 25.—Same block, 15-light standard plug; 5 amperes, standing on narrow end; face exposed; 1 minute 20 amperes; next 30 seconds 25 amperes; next 30 seconds 30 amperes. Blew.

No. 26.—Same block; face exposed; block lying on back; 30-light fuse; 10½ amperes. Carried 40 amperes 1 minute; 45 amperes, 1½ minutes, and blew; 400 per cent. overload.

No. 27.—Same as test No. 26.

The following tests were conducted in the power station of the University of Pennsylvania, Jan. 17, 1896, by courtesy of Prof. Spangler. Connections and instruments similar to tests made Jan. 14 were used. Connections were made across leads of a 110-volt, 500-light dynamo. The tests, as shown herewith are exceedingly interesting, as they were made upon larger fuse metals and fuse blocks than in test of Jan. 14.

No. 28.—Standard branch block; 30 amperes; 30 amperes standard fuse; 60 amperes, 3 minutes; 65 amperes, 1 minute; 70 amperes, 1 minute; no discoloration noticed; 75 amperes, 1 minute, standing upright.

No. 29.—Same block, same fuse; 80 amperes, 1 minute; 85 amperes, 1 minute; 90 amperes, 45 seconds; blew and arced 4 seconds; burned hole in mica.

No. 30.—Same block as No. 28; 30 amperes; standard fuse, touching mica. Carried 100 amperes 12 seconds.

No. 31.—Same block as No. 28; 30 amperes; standard fuse. touching mica; block face down. Current increased gradually to 75 amperes in 22 seconds.

No. 32.—Block upon edge, standing upright; same block as No. 28; 30 amperes; standard fuse. Carried 80 amperes 20 seconds.

No. 33.—Same block; 30 amperes; standard fuse link; 40 amperes, 1 minute; 45 amperes, 1 minute; 44 amperes, 2 minutes, 20 seconds. Kept reduced temperature until current was withdrawn.

No. 34.—Standard link fuse block; main line double pole; 50 amperes, fuse block resting on bottom; 50 amperes; standard fuse. Carried 70 amperes 45 seconds; 75 amperes, 1 minute; 80 amperes, 1 minute; 85 amperes, 2 minutes; 90 amperes, 1 minute 10 seconds; 95 amperes, 1 minute 20 seconds; 100 amperes, 1 minute 30 seconds; 105 amperes, 1 minute 10 seconds; 110 amperes, 1 minute 35 seconds; 115 amperes, 1 minute 10 seconds; 120 amperes, 1 minute; 125 amperes, 1 minute 60 seconds; 130 amperes, 1 minute 75, 74, 72 seconds. Arced 1

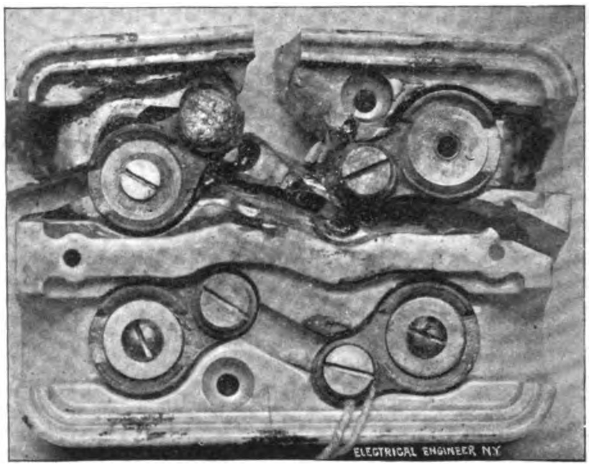


Exhibit With Test No. 34.

minute 7 seconds; 65, 70, 65 and 45 degrees, very bad continued arcing. No. 6 copper leads become hot, followed by insulation running, serious heating of wire (note size of wire). Destroyed block. (See exhibit.)

No. 35.—Standard 50-ampere D. P. Main line fuse block; 50 amperes standard fuse; fuse block upon its side. Carried 70 amperes 2 minutes; 75 amperes, 1 minute; 80 amperes, 1 minute; 85 amperes, 1 minute; 90 amperes, 1 minute; 95 amperes, 1 minute; 100 amperes, 1 minute; 105 amperes, 1 minute; 110 amperes, 1 minute; 115 amperes, 1 minute; 120 amperes, 1 minute; 125 amperes, 20 seconds; arced 3 seconds. Mass of molten metal laid in bottom, which arc could have passed over.

No. 36.—Same block; new side; 40 amperes; standard link fuse. Rated to blow at 50 amperes; 50 amperes, 1 minute; 55 amperes, 1 minute; 60 amperes, 1 minute; 65 amperes, 1 minute; 70 amperes, 1 minute; 75 amperes, 30 seconds. Slight arc.

No. 37.—Same block; 50 amperes, standard wire; lengthwise position; 75 amperes, 1 minute; 80 amperes, 1 minute; 85 amperes, 1 minute; 90 amperes, 1 minute; 95 amperes, 1 minute; 100 amperes, 1 minute; 105 amperes, 1 minute; 110 amperes, 1 minute; 125 amperes 13 seconds. Arced 13 seconds; destroyed block.

The following are quotations from various sources, and authorities, bearing upon fuse metals in general. Experimental and observed data have been accumulating very rapidly the last two years. The last year has been praticularly prolific in data.

A PROMINENT FUSE WIRE COMPANY'S CATALOGUE.

I.] The fusion necessarily depends upon all the elements that effect this heating. It takes time to heat even a wire, and people are sometimes greatly disappointed because a fuse does not open a circuit with the rapidity of a photographic drop-shutter the instant there is a sudden increase in load.

II.] It shows, however, that on account of the time required to heat the fuse to melting point, one cannot expect it to do the work of an automatic cut-out, which opens the circuit instantly at a set strength of current.

III.] If sudden increases in current cause other serious troubles, an automatic cut-out is wanted—not a fuse.

THE HEATING AND BEHAVIOR OF FUSE WIRES.

A paper read by Prof. W. M. Stine, H. E. Gaytes, and C. E. Freeman, before the American Institute of Electrical Engineers, Oct. 23, 1895.

IV.] We may now summarize some of the practical conclusions deduced. 1. Covered fuses are more sensitive than open ones. 2. Fuse wire should be rated for its carrying capacity for the ordinary lengths employed, 2a. When fusing a circuit the distance between the terminals should be considered. 3. On important circuits fuses should be frequently renewed. 4. The inertia of a fuse for high currents must be considered when protecting special devices. 5. Fuses should be operated under normal conditions to ensure certainty of results. 6. Fuses up to five amperes should be at least 1½ inches long, ½ inch to be added for each increment of five amperes' capacity. 7. Round fuse wire should not be employed in excess

of 30 amperes capacity. For higher currents flat ribbons exceeding four inches in length should be employed.

DISCUSSIONS FOLLOWING PROF. STINE'S PAPER ON "THE RATING AND BEHAVIOR OF FUSE WIRES."

V.] The Chairman (Prof. F. B. Crocker).—This paper, while dealing with a question that is by no means new, and should long ago have ceased to be a subject of discussion, is, nevertheless, one which is more constantly discussed and no more settled, than many of the problems which are far more difficult inherently. The physical conditions governing the fusion of a wire would appear to be very definite and easily determined. Certainly, no one would imagine that this sub-
VI.] ject would be one of the last to become definite from our point of view. But the fact remains, that to-day fuse wires are by no means relied upon; indeed, the very term "fuse wire" is almost synonymous with unreliability. It certainly would not seem that this is a necessary condition. I think it is owing to the fact that the length of the wire, the terminals to which it is attached, and the question whether it is enclosed or open, and many other important conditions, are entirely ignored. Under these circumstances, no scientific accuracy can possibly be obtained. But provided each fuse wire were rated at a certain length, and for use under certain conditions, I see no physical or other possibility of great variation between fuses. Nevertheless, the subject is so uncertain and so many engineers express their lack of confidence in the whole matter, that it is well worthy of consideration.

The Chairman.—That point, however, would relate rather to the question of fuses blowing sooner than they should, instead of not blowing when they should. It is those which do not blow when they are expected to trat rabe given fuses the reputation of unreliability. It is the fuses which carry two and three and four times their normal current, that electrical engineers are suspicious of, and not the fuses which blow too easily, although, of course, the latter is not desirable. A fuse
VII.] should not blow below its rated current. At the same time it is not those which have given the bad reputation to fuses. I have heard hundreds of times of fuses carrying a multiple of the currents that they were intended for, and a large multiple at that.

VIII.]Of course, in safety devices, on general principles, it is much better to have them act too soon than too late, as, for example, a safety valve.

IX.] Copper has a minimum specific resistance, and would have the minimum surface. That, I think, would make up for considerable difference in temperature. It has also been pointed out that, since copper has a very high temperature of fusion, the danger of setting fire to adjacent bodies is much greater when it does melt. But the low melting point alloys produce an arc when they blow, and, furthermore, any fuse should be wound.

X.] Mr. Howell.—Mr. Chairman, in practice, what fuses are called upon to go at a slight increase of current over their normal current?

XI.] The Chairman—There are two classes of fuses, but if I were asked to give examples of fuses that are called upon to yield at a certain definite current I would be puzzled to name them.

XII.] Mr. A. E. Kennelly.—I do not quite agree with Mr. Emery, that copper wires make the best fuses. It is often very convenient to use a copper wire for a fuse, but the difficulty with the copper wire is frequently that if you wish to employ a sensitive fuse that shall melt at only a small margin above its rated capacity, you must operate that copper wire red hot under normal conditions, in order that it shall melt at a reasonably small percentage above normal, and I think that has been the principal objection to copper wire fuses up to the present time.

XIII.] Copper wire fuses, on the other hand, melt at say, 1,050 C., which is a comparatively high temperature. Even granting the existence of a larger temperature coefficient of resistivity, the wire will have to be maintained at a comparatively high temperature by the normal current strength if it is required to melt at a small overload. In point of fact, the temperature coefficient of copper does not seem to differ greatly near red heat from its value at the boiling point of water, and in some cases it would be necessary to keep the wire at 500 C., or about red heat under working currents in order to effect fusion at a comparatively small excess of current.

XIV.] Mr. R. T. Lozier.—I think one of the most important points that Prof. Stine has called attention to is conclusion 3, that is to say, frequently renewing the fuses. I know when I was connected with the Edison company that the oxidation of the fuses in the street circuit boxes was rectified by changing the alloy to overcome that objection. I know that in practical experience, that point of changing the fuses is one that is seldom recognized. It is one that I did not know myself. I think that that one fact alone is a very important one to the profession.

XV.] Mr. T. Wolcott.—I think that conclusion 3 is quite an important one—that on important circuits fuses should be frequently renewed. If a fuse is run up to its rated capacity all the time that certainly is very important. The metal will change of course. That is shown in the paper here how the metal changes when the current is turned on. You certainly find
XVI.] That in ordinary fuses. I think the Chairman is entirely right in this matter. An instance of the trouble you generally find in fuses is this: If there is a fuse for a single light in the base of the lamp it sometimes will stand more than the plug that supplies the whole room, that is, the plug will blow and put out all the lights in the room, instead of the single light fuse blowing.

PROPERTY OF FUSE METALS WHEN SUBJECTED TO SHORT CIRCUITS. A PAPER READ BEFORE THE NIAGARA FALLS MEETING OF THE A. I. E. E.

BY WALTER E. HARRINGTON.

XVII.] The natural conclusion arising from a knowledge of the above data, is that fuse metals are under no circumstances to be considered in the light or nature of a protection.

DISCUSSION OF MR. WALTER E. HARRINGTON'S PAPER.

XVIII.] Capt. Wm. Brophy.—Nearly every point in this paper been covered, and discussed, except the concluding paragraph. I must say that I am nearly in accord with the writer in what he there says. I would simply amend it in this way: "The natural conclusion arising from a knowledge of the above data is that fuse metals are, under most circumstances," etc. It has been my province to deal with fuse metals for the last twelve years. The functions which are required are prevention of an abnormal flow of current over the wires, thereby increasing their temperature to a dangerous point. I have only very recently tested commercial fuses —sent out and bought them—and I find that none of them come anywhere near doing what they are advertised to do. The current that they carry varies from 50 per cent. to 250 per cent. above what they are marked. Many of them have the same property as copper wire—they heat; and I have maintained them in a red hot condition for ive or ten minutes or longer, if I so desire. I would like to see something substituted for the present commercial fuse, for a great many reasons. The men in charge of large plants are apt to use fuse metals that are entirely too large, even if they did what they are supposed to do, protect the wires in which they are inserted. As they age, I find that their carrying capacity increases very rapidly. In fact, there are innumerable objections that could be stated to the use of fuse metal for the protection of wires and prevention of overheating the same if time permitted.

XIX.]Prof. F. B. Crocker.—Any fuse would carry an infinite rent for an infinitesimal period of time; or, to put it a little more practically, it would carry a very great current for a very short time.

XX.] Mr. Blodgett.—The shape of the fuse has also an important bearing on the temperature at which it will melt. If it is in the form of a flat strip it will carry a higher current than if it is in the form of a solid rod or circular wire, particularly if it be intended to carry a larger current.

Editorial in the Nov. 20, 1895, issue of "The Electrical Engineer," entitled "Untrustworthy Electrical Mechanism."

XXI.] A survey of the work accomplished by the electromagnet would seem to demonstrate that, as a prime mechanism, pure and simple, it leaves little to be desired as regards faithfulness and accuracy of work. The trouble that has been developed occasionally in the past may almost invariably be traced to bad auxiliary mechanism, which has caused the condemnation of entire classes of apparatus embodying electro-magnets in their construction. We need only to refer to the early use of electro-magnetic cut-outs in electric lighting work and their abandonment in favor of the fuse. Yet it is doubtful if a more untrustworthy device can be found in the whole range of electrical applications, in proof of which we need only refer the reader to the elaborate tests of Prof. W. M. Stine, and associates, given in their Institute paper now appearing in our columns. As a result, we note a decided tendency to revert to the "old reliable" electro-magnetic cutout."

Synopsis of paper read before the National Electric Light Association in Washington, on "Some of the Faults Inherent in Fuse Metals":

XXII.] 1. Lack of uniformity in proportions and mixing the constituent alloys of the fuse, also in the methods of drawing the wire to a uniform geometric cross-section, and in preparing the fuse for the market. 2. Lack of uniformity, in practice,

in the actual placing of the fuse, in the following particulars: (a) Length of fuse for a given service. (b) Mass of the terminals used. (c) Position of fuse, as to whether it be vertical or horizontal. (d) Environment, as to whether it be held in suspension between terminals, or be allowed to lie along its entire length upon a mass of heat-radiating material, and whether it be open to the air or enclosed in a chamber. 3. Deterioration caused by: (a) Recurring abnormal currents. (b) Oxidation from various causes. (c) Disintegration from local voltaic action. 4. Impairment of contacts at terminals, due to loosening of the clamps from temperature expansions and contractions, or to mechanical or electrical causes. 5. The "Peltier" effect. 6. The abuse of acceptable (?) fusing devices, by substituting for the metals designed to be used in them others that are unsuitable. 7. Time element. Practice has demonstrated that fuses rarely, if ever, "blow" in time to accomplish the object for which they are placed in circuit. There is also a wide range of uncertainty as to the constancy of this period for any given fuse. 8. Capacity of the ordinary fuse wire to pass current far in excess of its rated blowing capacity for a period of time sufficient, in a majority of cases, to cause damage to some portion of the circuit.

A letter by Mr. Walter E. Harrington to "The Electrical Engineer," Nov. 27, 1895:

"Mr. James H. Bates' letter in "The Electrical Engineer" of Nov. 20, is more interesting to me than mine was to him, as he agrees with me that magnetic circuit breakers are a necessity, as would be implied in his statement: 'The magnetic circuit breaker is essential in a case like heavy railroad work, where a circuit breaker controls a large volume of current.'

"Mr. Bates makes light of the fuse protection of jaws of switch to prevent blistering of the contacts, and to emphasize this triviality (?) he more prominently identifies himself in favor of magnetic circuit breakers, as the following statement shows:

XXIII. To weigh such a comparatively trifling (?) matter against so great an advantake as pointed out is extreme folly, for what does a little blistering amount to, compared with the safety of apparatus?"

"What Mr. Bates seems to think an insignificant matter, and, as he states, 'may be remedied by proper design' has been the opinion of several engineers with whom I have discussed the matter of magnetic circuit breakers. Yet why is it not done? The answer is simple. I have been three years reading papers based on practical tests of different kinds to demonstrate the gross untrustworthiness of fuses. Engineers at large are wedded to the old time fuses. Only one month ago, in conversation with one of the most prominent electrical engineers in the East, he stated positively, as his opinion, 'he did not see wherein anything was gained by using magnetic circuit breakers on a railway switch-board, let alone on cars.'"

"He further stated, that a fuse and a magnetic circuit breaker of equal capacity would, in event of a short circuit, permit the passage of the same volume of current. As long as our prominent engineers keep ignorant of the practical behavior of fuse metals (I would here refer to Prof. Stine's and associates' paper on "Behavior and Rating of Fuse Metals," read recently before the A. I. E. E.) just so long magnetic circuit breakers will not be used generally."

"I felt, when I prepared a paper on the behavior of fuse metals on 500-volt short circuits, that when it would be presented to such an august body as the A. I. E. E. it would be taken in the spirit presented. But when such engineers as Prof. Elihu Thomson, C. P. Steinmetz and others, lost sight of the salient facts contained in the paper and discussed methods employed, and in some cases praised fuses—well! The only engineers who, by their discussion showed a realization of the facts were Prof. Crocker and Captain Brophy."

"Here and there an engineer stands out in favor of magnetic circuit breakers for general use. I might mention Dr. Cary T. Hutchinson, C. O. Mailloux, Mr. Tapley, of the United States Printing Office; Mr. Chas. Hewitt, and others. In conclusion, I must add one more name to the list—Mr. James H. Bates."

LESSONS.

1. Fuses carry 50 to 200 per cent. current in excess of rated fusing current.

See:—Tests, also paragraphs VI., VII, page 10; paragraphs XVI. page 12; paragraph XVIII., page 13; paragraph XIX., page 14; paragraph XXII., page 15.

2. Under "Short Circuits" a fuse will carry excessively abnormal currents:

See tests Nos. 1, 3, 6, 7 and 38.

See paragraph III., page 8; paragraph IV., page 8; paragraph XVII., page 12; paragraph XIX., page 14, and paraprаph XXII., page 15.

3. Fuse metals made of alloys, so as to have a low temperature melting point, will maintain at a red heat, making a serious fire risk.

See tests Nos. 3, 4, 5, 8, 12 and 33. See paragraph XVII., page 16.

4. Metals such as copper, aluminum, iron, etc., are not adapted for fuse metals, owing to the high temperature required for fusing. To be reasonably sensitive, they must be maintained at a red heat, which is not permissible, owing to fire risk.

See paragraph IX., page 10; paragraphs XII., XIII., page 10; paragraph XVIII., page 13.

5. Fuse metals arc and make a serious fire risk. See tests Nos. 14, 15, 19, 21, 34, 23, 35 and 37. See paragraph IX., page 10.

This phenomenon was very pronounced, using different length fuses, and, placing fuse blocks in different positions. In my judgment, this is a fault inherent in fuse metals, due to the fact that the molten metal can still carry current and the arcing will jump the slight distances intervening between the terminals and the molten metal, although an arc can be maintained without the presence of the molten fuse metal.

6. Enclosing a fuse is not safe, as the gases generated upon the fusion of the metal will continue to carry the current in event of a short circuit. See paper read before the American Street Railway Association at Atlanta, Ga., entitled, "Destructive Arcing of 500-Volt Fuses."

7. Fuse metals are very sluggish in fusing, and in this one factor make a serious fire risk, as the current flowing in many instances permits the wire under insulation to become hot or intervening space between wires, if a leak arises, to become hot. See test Nos. 34, 35, 36 and 37. See paragraph I. page 8; paragraph II, page 8; paragraph IV., page 8; paragraph XXII., page 12.

8. Fuse metals are generally unreliable, as their position, length, age, oxidation, shape, composition, temperature, terminals, all affect their fusing point. No standard fuse block and fuse could be established, but what some of the above factors would enter in to cause a variance in the result. See tests 28, 29, 30, 31, 32 and 33. See paragraph IV., page 8; paragraph XIV., page 10; paragraph XVIII., page 13; paragraph XX., page 14; paragraph XXI., page 14; paragraph XXII., page 15. (The page numbers refer to MSS report.)

REMEDY.

Attempts were made in the early days of electric lighting to use automatic magnetic circuit breakers in place of fuse metals. Owing to the lack of proper mechanical design of these early electro-magnetic safety devices, their use was abandoned. In the last few years, however, as a substitute for fuses, automatic magnetic circuit breakers have been adopted in power transmission, railway work, isolated lighting plants, and storage battery installations, independently of any requirements of boards of fire underwriters, as engineers have long realized by practical experience the untrustworthy character of fuse metals. I would here refer to the editorial in "The Electrical Engineer," in paragraph XII. of this report. I have made a careful detailed investigation, visiting power stations where the modern magnetic circuit breakers are used, and have also made personal tests; while I have found certain faults in the design and mechanical construction of some of the magnetic circuit breakers now in use, in no instance are those faults comparable to the more serious inherent faults in fuse metals. An automatic magnetic circuit breaker depends for its action upon the magnetic quality of the current. This action is instantaneous. (A fuse depends for its action upon the heating quality of the current. This action is necessarily slow, and it is inherently foreign to the purpose the fuse is intended for, to wit—protection.) I believe automatic magnetic circuit breakers should be employed to protect all circuits of over 10 amperes capacity.

After carefully considering the several features in principle and design of automatic magnetic circuit breakers, I would consider that an automatic magnetic circuit breaker embodying the following particulars would be an entirely satisfactory electro-mechanical device for the protection of electric circuits. 1. A magnetic circuit breaker, wherein no springs are permitted in its adjustment. Adjustment should be effected by means of distances. 2. Magnetic circuit breakers should have the feature of opening the circuit in less and less time, as the conditions of the circuit protected approach a short circuit. The electro-magnetic part of circuit breakers should be designed to develop more energy than is necessary to trip retaining catch. The additional energy developed should be applied directly to aid in opening the switch. It immediately follows from this that as the current flowing through the device exceeds the amount of adjustment, the switch, will of course be more quickly and positively opened.

3. The magnetic circuit breaker should be so constructed that, with the minimum current flowing through it necessary to open it, the blow struck or power exerted by the plunger or armature should, if it moves at all, under conditions, be such that the switch will open.

4. The electro-magnetic mechanism wherein any insulation enters into the construction of the trigger or catch, should not be permitted, owing to the tendency of the insulating composition to ultimately break down.

5. It would seem desirable to have the magnetic circuit breaker so constructed, that, in event of the circuit breaker opening, owing to overloaded condition of circuit, if same overloaded condition continues at the time circuit breaker is thrown in, the catch will not engage.

6. Where magnetic circuit breakers are to be employed in damp places, all bearing pins and parts liable to be affected by rust, should be of phosphor bronze, and moving iron parts plated.

7. The armature or plunger of the magnetic circuit breaker should not be permitted to act on the retaining catch or switch arm, without a free preliminary movement preceding such action. The reason for this is apparent, as the adjustment would be then effected by the friction of catch or arm.

In conclusion, to condense the above features to form a specification to cover what would constitute an "approved" automatic magnetic circuit breaker, I submit the following: An "approved" type of automatic magnetic circuit breaker must embody the following features:

1. The magnetic circuit breaker must have the features of opening the circuit in less and less time as the conditions of the circuit protected approach a short circuit, that is, have an inverse time element. The electro-magnetic part of circuit breakers must be designed to develop more energy than s necessary to trip the retaining catch. The additional energy developed should be applied directly to aid in opening the switch.

2. A magnetic circuit breaker wherein no springs are permitted in its adjustment.

3. Insulation must not enter into the construction of the trigger or catch.

4. All bearing pins and parts liable to be affected by corrosion or rust must be of phosphor bronze, and moving iron parts copper plated.

5. The armature or plunger of the magnetic circuit breaker must not act on the retaining catch or switch arm unless a free preliminary movement precedes such action.

ELECTRIC TRANSPORTATION.

THE DUBLIN-DALKEY ELECTRIC TRAMWAY.[1]

THE conversion of the original horse tramway between Dublin and Dalkey into an electric line having now been practically completed, and successful trial runs of cars over a portion of the line having already taken place, the interesting event of the inauguration of this line may be expected shortly to occur. The line is owned by the Southern District Tramway Company, of Dublin. Starting from Dublin at a point about half a mile north of Balls' Bridge, where the generating station is situated, the line passes through Donnybrook, Williamstown, Blackrock, Kingstown—where a branch traverses streets leading to the harbor—and thence to Dalkey. Throughout the greater part of its main route the tramway is roughly parallel with the Dublin, Wicklow and Wexform steam railway.

Acting upon the advice of their consulting engineer, Mr. J. Clifton Robinson, the Tramway Company gave the contract for the electrical equipment of the line, the reconstruction of the track and of the buildings for the power station and substations, and the erection of the generating plant, &c., to the British Thomson-Houston Co. The track, which is 7¾ miles in length, is on the whole, fairly level, the principal gradients being 1 in 16, 1 in 23, and 1 in 29. It is double throughout, except for a short distance in two places. The gauge is 5 ft. 2 3-16 in., and the rails, which are of 76 ℔. size, with massive fish-plates, are laid in concrete. The electrical equipment of the track is upon the overhead trolley system, span wires being principally used, with center poles in some of the narrower streets, and along the chief road through which the Kingstown branch passes. The style of the center poles is shown in Fig. 1, from which it will be seen that these are far from being inartistic. Indeed, the appearance of the center poles, with double brackets is undoubtedly superior to that of the plainer side poles, with their numerous span wires crossing the streets at right angles. The return current is through the rails, which are bonded on the Chicago plan, single bonding being used throughout, with cross-connections at every 120 ft. The trolley wires, which are duplicated throughout, are of hard-drawn copper, 320 mils in diameter. The poles, whether for the central or side construction, are of steel tubes in three sections, with hot-shrunk overlapping joints. They are grounded to a depth of 6 ft. in concrete, a cast-iron base and footplate being fitted over the lower end of the pole. At the ends of each half-mile section, section insulators are used; and here the ends are connected to rubber-covered cables leading down the poles to the switch pillar, in which there are switches, by which the sections may be connected to the continuous-current feeders. These switch pillars are erected along the route, beside the vehicular way; they are of cast iron, and in general appearance resemble postal pillar boxes, except that they are of a more ornate design. They are 4 ft. in height and 18 in. in diameter.

One of the most interesting features of the Dublin-Dalkey tramway system consists in the adoption of power transmission by means of polyphase currents, between the power house and the two sub-stations which feed the line en route. The position of the power station would have rendered it difficult to comply with the Board of Trade regulation in regard to the drop of pressure on the return circuit through the rails, except by means of sub-stations at the far end and an intermediate point on the line. This regulation insists that the fall of pressure on the entire length of the return circuit shall not exceed 7 volts. It was, therefore, considered desirable to adopt polyphase transmission between the power station and the two sub-stations, the one at Dalkey and the other at Blackrock. The sites for the main and secondary stations

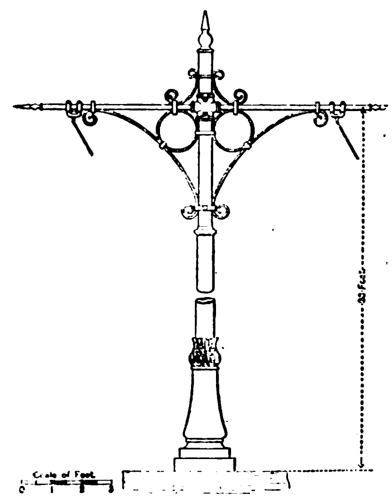


FIG. 1.—CENTRE POLE BRACKET, DUBLIN–DALKEY TRAMWAY.

were fixed by the existence of car sheds and stables, belonging to the original horse tramway system, at these places; and the old buildings on these sites have been partially utilized and reconstructed to suit their present purpose.

The power house is situated on the banks of the River Dodder, which provides water for condensing purposes. The equipment of the power house provides plant for directly feeding the nearer end of the line with continuous current at 500 volts; as well as for transmitting three-phase power, at from 2,300 to 2,500 volts, to the distant sub-stations. The arrangement of the station equipment is shown in Figs. 2 and 3.

In the boiler house there are some interesting features. There are three Babcock-Wilcox boilers, each provided with double steam drums, of 250 H.P per boiler. These develop a normal pressure of 140 ℔. on the gauge. The boilers are fired mechanically, by means of Vicars stokers; and the gear for these stokers is driven by a G. E. shunt motor, which also drives the scrapers in the Green's economizer. The feed water is supplied either by means of an injector, or by two three-throw pumps, made by Messrs. Daniel Thompson & Co., each of which is driven by a G. E. motor, of the same type as those used on the cars, but shunt wound. All the motors in the boiler house are worked from the bus-bars, at 500 volts, through special rheostats and switchboard. The feed pumps are capable of supplying 16,000-℔. of water per hour.

In the machinery room there are at present four generating sets, each driven by a 150 B. H. P. Willans (H. H. S.) compound condensing, two-crank engine, running at 380 revolutions per minute, with steam at 140 ℔. The engines have been specially strengthened to stand the severe loads which traction work temporarily imposes and will develop 175 B. H. P. for a short time on occasion. The engines are adapted to belt driving,

[1] London "Electrician."

each being provided with a 3 ft. 10 in. flywheel pulley, and with an outer bearing. Two of the engines drive two "B. T. H." 100-kilowatt four-pole tramway generators at 625 revolutions per minute. These are compound wound for 500 volts at no load and 550 volts at full load. The other two engines are belt coupled to two eight-pole, three-phase generators, each capable of developing 120 kilowatts at from 2,300 to 2,500 volts, running at 600 revolutions per minute. These machines were designed by Mr. H. F. Parshall, and were manufactured at Newcastle-on-Tyne by Messrs. Armstrong, Mitchell & Co. In addition to these four generating sets, there is a "B. T. H." four-pole motor generator of 30 kilowatts capacity, consisting of a 500-volt shunt motor direct coupled to a 125 to 140-volt continuous-current generator for supplying the station lights and charging the storage batteries. This motor generator is situated at one corner of the machinery room, in line with the dynamos, as shown in Fig. 2.

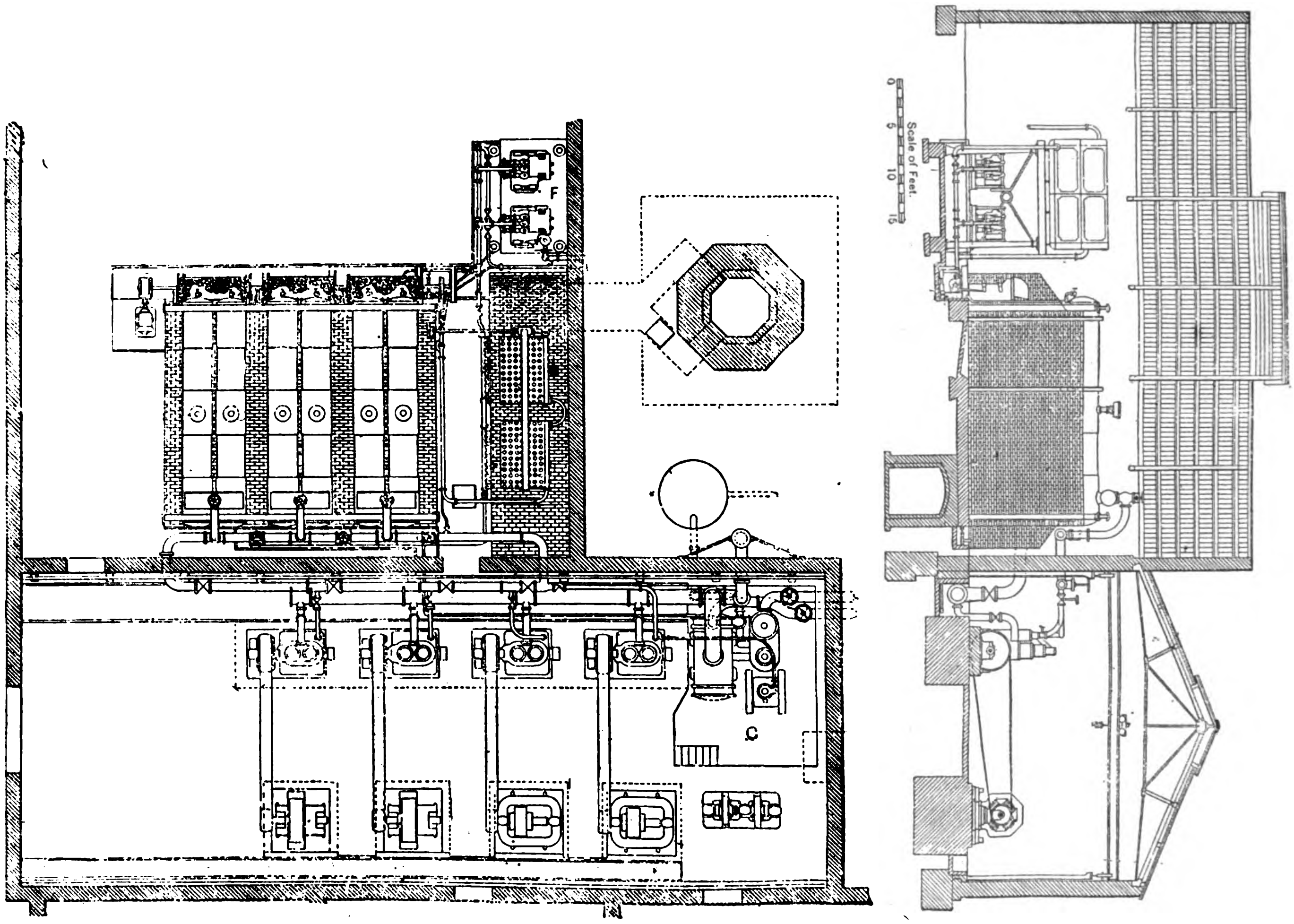
The accumulators are of the Epstein type, there being 55 cells of the R 11 pattern, having a capacity of 600 ampere-hours.

The repair shops are fitted with a complete set of machine tools, consisting of lathe, shaping machine, drill press, hydraulic press, grindstone, blacksmiths' forge, &c., and a full equipment of small tools. The machine tools are driven by belt from a counter-shaft operated by a "G. E." shunt-wound motor, run off the 500-volt circuit. The testing room contains the usual testing instruments, a battery of 50 small accumulators, and a portable Silvertown set.

The present rolling stock comprises 20 motor cars, each double-decked and capable of seating 20 passengers inside and 30 on top, the length inside being 16 ft. 6 in., and over platforms 27 ft. 2 in.

At the Blackrock sub-station the plant consists of two direct-coupled units, each consisting of a synchronising motor, coupled to a 60-kilowatt continuous-current generator. The motor receives the three-phase current at about 2,300 volts pressure, and the generator produces current at a pressure of 500 to 550 volts. Suitable switching gear is provided to enable the generator to be started from the trolley wire feeder to run the motor before throwing it into circuit. There is also a set of switching gear for controlling the direct-current generator, and connecting it to the 500-volt trolley wire feeder. The plant at the Bullock Hill sub-station, at Dalkey, is similar, except that the generators have a capacity of 50 kilowatts each.

Current is carried from the power house by two sets of feeders, one being for the 500-volt direct current, and the other for the 2,500-volt three-phase system. The 500-volt feeders, which supply current to the overhead trolley wire, consist of Callender's lead-sheathed armored cables of 0.08 sq. in. and 0.15 sq. in. section. The former cable extends from the power station as far as Blackrock sub-station, but the latter, of course, extends to the Bullock Hill sub-station. The three-phase current is carried from the power station as far as Blackrock sub-station by two triple concentric cables, each of 0.0496 sq. section, and from thence to the Bullock Hill sub-station by one triple concentric cable of the same section. These concentric cables are of the British Insulated Wire Company's lead-sheathed and armored type. In addition to these feeders there is a three-core Callender lead-sheathed and armored cable, one conductor of which is used as the test wire. The other two conductors are for the telephone system. This cable is led into the feeder switch pillar, and connected to telephone instruments placed at every half-mile along the line, and is also carried into the power house and sub-stations, where telephone instruments are fixed.



FIGS. 2 AND 3.—DUBLIN-DALKEY ELECTRIC TRAMWAY POWER STATION.—PLAN AND SECTION.

BRIDAL TOUR BEGUN ON TROLLEY.

It is something of a novel sight to see a bridal party riding through the country on a trolley road. At the great Borden farm, at Wallkill, N. Y., twelve miles back of Newburgh-on-Hudson, where condensed milk is manufactured, Miss Nellie Borden, daughter of Gail Borden, the owner of the condensary, and Mr. Hamilton, of New York, were married. After the wedding some thirty friends who were present escorted the newly wedded pair to the Newburg and Walden trolley road, a short distance away, and started them off on their novel bridal tour.

AIR BRAKES AND ELECTRIC BRAKES.

AN interesting editorial discussion of the present status of street car braking appeared in the London "Electrical Review" of December 27, the text being the paper presented by Mr. E. J. Wessels at the Montreal Street Railway Convention. We have been favored by Mr. Wessels with a copy of his reply to some of the comments of our contemporary, and publish below the letter written by him as general manager of the Standard Air Brake Company.

Sir:—While sensible of the honor you do our general manager quoting so freely from his Montreal address, we are sure you will not consider it amiss if we should make some comments on your article, especially its closing sentence, which says: "One would not wisely endeavor to apply an electric brake to a steam locomotive, nor does it seem any more desirable to get up air pressure on an electric car for brake purposes."

We cannot assent to the argument. We do not think the analogy is sound. If anything has been settled about the latest practice in the United States, it has been the fact that the successful electric brake is yet to be born. Further, those electric brakes which were so freely brought to the public notice have been obliged to retire from the field. Even the remaining electric brake now being advertised is not what it should be. It will take considerable cash, labor and time before it becomes commercial. In view of this, you are quite justified in saying "One would not wisely endeavor to apply an electric brake to a steam locomotive."

With the air brake, however, the conditions are vastly different. We do not use steam to generate pressure, but in most of our installations depend either (directly or indirectly) upon the car axle for compressed air. By means of patented improvements the pressure cuts in and out automatically, so that the amount of power consumed is very small. When the compressor is cut out there is positively no power consumed.

In the first paper the writer had the honor to present before the American Street Railway Association in Atlanta (in October, 1849), he pointed out reasons why air brakes are destined to supercede all other forms of brakes and why they are more reliable than electric brakes.

To reproduce that article would consume too much of your space, but as the address has been extensively reproduced here and abroad, your readers will have no difficulty in referring to it for points.

For braking cars operated at extraordinary speeds we furnish our electric compressor type. For running its slow speed series wound motor we tap the motor wiring of car. For our most exacting requirements, even when compressor-motor is running at its highest capacity, we consume scarcely as much current as is required for two ordinary lamp circuits. It is only in very exceptional cases that the compressor-motor will run at this rate for more than a few minutes at a time.

It has been demonstrated here that one cannot rely upon the electric brake as certainly as upon the air brake. Without going into an elaborate argument, it is obvious that special reservoirs filled with compressed air, available for making 100 or more stops, will always prove a greater source of safety than other forms of apparatus, far more liable to get out of order.

You state "The general impression conveyed by the paper and discussion is that, so far, air brakes have not been found altogether successful in American tramway work, but that their need is greatly felt." In his paper writer certainly understated the merits of air brakes rather than risk over-stating them. The paper, while it did not advance the idea that perfection had been reached in air brakes, distinctly stated that there was one type of commercial air brake in existence.

The Westinghouse air brake (which made its bow to the public twenty-seven years ago) is not absolutely perfect, but, as writer showed in Montreal, it has saved thousands of lives and millions of property. Moreover, our street railway air brakes have proved altogether successful, and you seem to have misunderstood the article in judging otherwise. You state: 'To-day there is not an air brake in St. Louis, although in that city they had a splendid start," etc.

We can best answer that by quoting verbatim from an advertisement we inserted in "The Street Railway Journal," December, 1895, under heading, "A Point About Discussions." We quote therefrom as follows:

"That was a most interesting discussion which followed Mr. Wessels' paper on 'The Present Status of the Air Brake,' read before the Montreal Convention. He distinctly announced that his paper was not written for advertising effect. Nor would he violate professional etiquette by mentioning any names.

One St. Louis manager stated several objections had been made to air brakes on a road in his city.

He should have made clear, but failed to do so, the fact that those air brakes were not ours, nor have we ever had any connection with them, near or remote. The comical part is that the air brakes the gentleman referred to were never used on his road. He spoke only from "hearsay." No court of law receives such testimony as evidence. Neither should you, at least without ascertaining the facts in the case.

The truth is, these obsolete air brakes were in Mr. Wessels' mind when he read from his paper: "There were air brakes which entered the lists at the last convention which have retired from the field; some are still bearing the heat and burden of the day. It is a case of the survival of the fittest. Our air brakes are 'bearing the heat and burden.' "

In replying to the gentleman, Mr. Wessels showed that the St. Louis and Suburban Road was the one on which the air brakes referred to were operated, and that they felt the need of air brakes so badly that they themselves rebuilt those which broke down.

And since then that air-brake system has become obsolete. These brakes were manufactured in the West. Ours are manufactured in the East, and remain. We are still doing business at the old stand.

By the way, wouldn't it have been far more interesting for the convention to have heard directly from some one connected with the road to which the gentleman referred instead of listening to an outsider who could not speak officially about what he didn't know except at "second hand"? I think so.

As illustrative of the perfectly successful operation of our air brakes, we ask your attention to the article in "The Street Railway Journal" for February, 1896, in which you will observe a number of cuts of cars being successfully braked by the "Standard." We also send you under separate cover an electro of a heavy car used on the Pacific slope, which you will, perhaps, be kind enough to reproduce with this letter.

We are now filling the third order from that road. Had our air brakes not been successful the buyers would not have, after a year's trial, sent us the third order to equip twenty-eight additional cars.

But perhaps the best evidence of the success of our air brakes is the fact that hundreds of them are in satisfactory operation around the globe. Modesty kept the writer from mentioning that fact on the convention floor.

ANOTHER MOTOCYCLE RACE.

The "Cosmopolitan Magazine," in its February issue, publishes the details of its offer of $3,000 in premiums to be awarded to motor carriages presenting the greatest number of points of excellence as exhibited in a trial trip, to be made on Decoration Day, May 30, next, from City Hall Park, N. Y., to the Cosmopolitan Building, Irvington-on-Hudson, N. Y., and return, a round trip of fifty-two miles. The award will be made on the following points, the maximum being 100: Speed, 50; simplicity and durability of construction, 25; ease in operating and safety, 15; cost, 10. Entries are to be made before May 1. The names of the judges will be announced later.

The route selected is "along Broadway to Central Park, through the park to Washington Bridge, thence along Broadway continues to Yonkers, where the course will include five miles of asphalt pavements; then following the country Broadway to Irvington, paralleling the Hudson and passing through one of the most beautiful regions of America. The roadway over which the trial will be made is not excelled even in France."

An article in this issue of the "Cosmopolitan" on "The Progress of the Horseless Carriage" shows illustrations of the "Electrobat," an electric brougham and an electric delivery wagon, and mentions the Holtzer-Cabot vehicle, as well as illustrating and describing other methods of propulsion.

THE "MOTORMAN'S POSE."

What might be called a "motorman's pose" has been developed by the trolley cars, according to observations made at a ball given by the trolley motormen in Worcester, Mass. It is alleged that while resting between the dances every motorman stood on one foot. When running a car the motorman must stand on one foot and have the other free to pound the gong, the gong being pounded incessantly, as any Brooklynite will testify. Thus a necessity of work has developed into a habit at all time. This is a subject for the consideration of the evolutionists.

THE TROLLEY AND THE READING ROAD.

The annual report of the Philadelphia and Reading road, just issued, states that the competition of suburban electric roads had decreased the earnings from passenger traffic $178,887. There was a decrease in short-distance travel, and an increase of passenger for long hauls.

POWER TRANSMISSION.

RECENT GENERAL ELECTRIC MINING APPARATUS.

THE General Electric Company has, since it first entered the mining field, kept steadily in view the improvement of its electrically operated apparatus

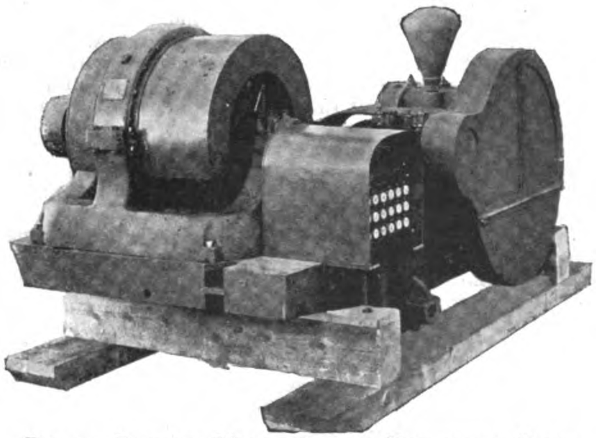


FIG. 1.—ELECTRIC MOTOR DRIVING HORIZONTAL PUMP.

for that class of work and its adaptation to the special conditions of the mining industry. The illustrations herewith show a few examples of recent appliances produced at its works and now in successful operation.

Fig. 1 shows a $6\frac{1}{2}$ inch by 8 inch horizontal triplex pump, directly driven by a 10 horse power, four pole slow speed motor through two reduction gears, the entire combination on the same base being mounted on a truck for ready transportation from place to place in the mine. The motor is controlled by a rheostat set at the side and, like the motor, housed in with a sheet iron cover. The illustration shows the truck mounted on wooden base for shipment.

Fig. 2 shows a root blower driven by a four pole slow speed motor of 15 horse power capacity and mounted on a common base frame. Fig. 3 is a 60 inch steel plate exhaust fan operated by a $2\frac{1}{2}$ horse power four pole motor. The fan makes 480 revolutions per minute and has a capacity of 8,300 cubic feet of air per minute at $\frac{3}{4}$ oz. pressure.

The slow speed motors driving the above mentioned

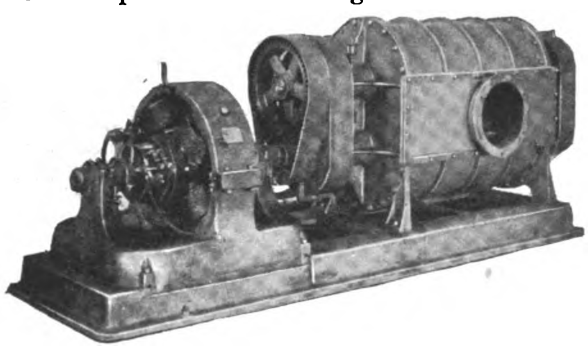


FIG. 2—ELECTRIC MOTOR DRIVING ROOT BLOWER.

apparatus are recent developments in the motor line, designed for use on direct current circuits. For outputs greater than 5 horse power, they present decided advantages over motors of bi-polar type. They are compactly built and admit of direct combination with machinery without greatly increasing the space occupied. They operate at slower speed than any other motors of similar capacity yet built, and although reduction of speed must necessarily imply increase of weight, in this case it appears to be amply compensated for by economy of material effected by the adoption of the four pole type. The frames and fields are of special soft cast steel, which, possessing high magnetic permeability, allows of the construction of a very light motor. The armatures are thoroughly ventilated; and the windings of copper wire, first

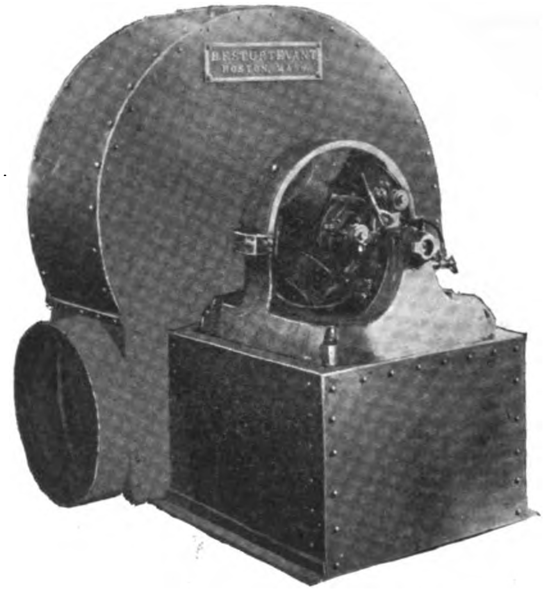


FIG. 3.—ELECTRIC MOTOR DRIVING 60-INCH EXHAUST FAN.

formed and insulated, are embedded in slots in the armature core, and bound down securely on the projecting flange of the armature spider. The coils can be easily removed and replaced. The machines are sparkless and the load can be varied from nothing to full load without the necessity of shifting the brushes. Precautions are taken to prevent any tendency on the part of the bearings to get out of alignment and proper contact of brushes with the commutator is insured by special construction of the brush holders.

Another combination, introducing the multiphase motor for use on alternating current circuits, whether monocyclic or multiphase, is shown in Fig. 4, illustrating a triplex vertical single action pump, directly connected to a 220 volt 60 cycle, ten horse power, multiphase motor. This type of motor developed by the same company, aside from its compactness, which allows of its erection in a restricted space, has the additional advantage of being absolutely without brushes, commutator or moving wires. It requires no

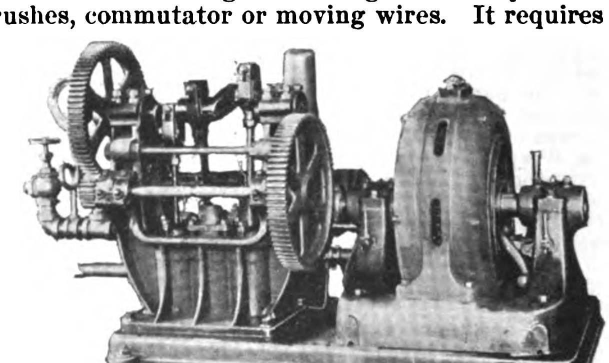


FIG. 4.—MULTIPHASE MOTOR DRIVING VERTICAL PUMP.

attention and may be stopped and started under full load or no load. These motors are now in use on all the three-phase monocyclic power transmission circuits in this country, operating without attention and without accident and to the entire satisfaction of the user.

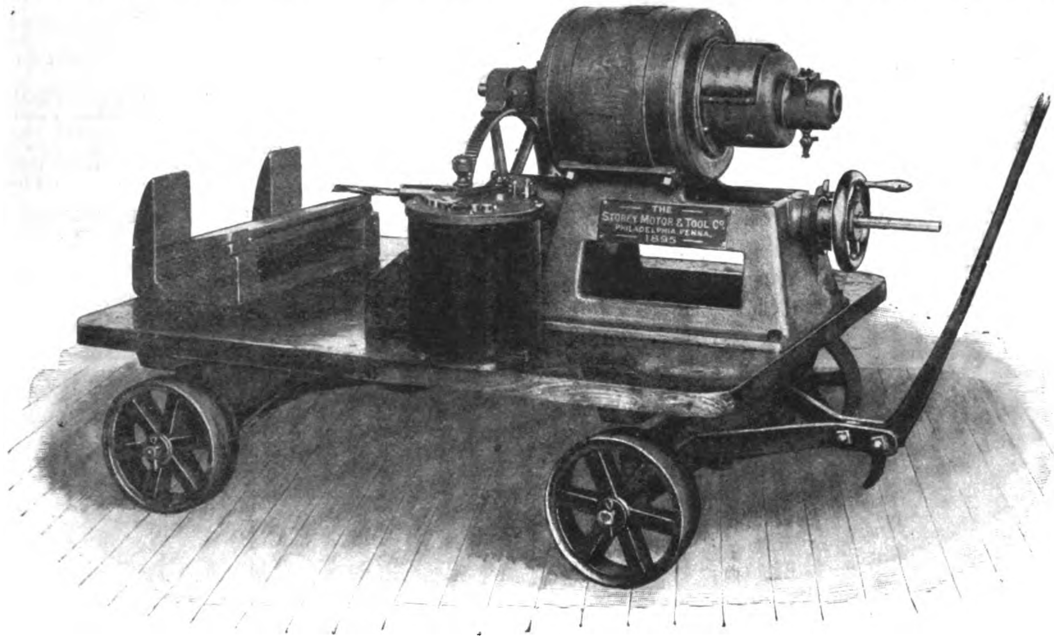
THE STOREY PORTABLE ELECTRIC DRILL.

THE STOREY MOTOR AND TOOL COMPANY of Philadelphia some time ago put on the market a compact and efficient portable drill, which we illustrate herewith. This machine is adapted for drilling pig iron and copper for test work, drilling rails and for various other kinds of work. Owing to the type of the motor, which is entirely enclosed, it is suitable not only for indoor work, but can also be used for outdoor purposes without requiring any specially arranged covering for its protection.

The outfit complete, illustrated in the accompanying engraving, consists of motor and drill combined, together with regulating rheostat, for obtaining any desired speed, and a drum with 100 feet of flexible cord, all mounted on a truck, with or without rack for holding material to be drilled, as desired. These machines drill in sizes up to 1½ inches in steel and 2 inches in cast iron, and are furnished with both automatic and hand feeds.

The rapid adoption of electricity in machine shops and factories makes a tool of this kind extremely useful, as it can be moved at will wherever it is needed. These drills can also be placed on a table or in any stationary position, and will cover a large range of work of different classes. As an illustration, two of these drills are mounted on bed plates, one at each end of a large callender roll, drilling two holes in flanges at the same time and tapping them in the same operation, before the roll is moved. Another adaptation of this drill is where it is fitted with a telescoping shaft and is used in yards for drilling holes in the construction of switches and crossings for street car and railroad work.

A different type of portable drill is being brought out by the Storey company and will be ready for the market in a few weeks.



STOREY PORTABLE ELECTRIC DRILL.

A MATHER POWER TRANSMISSION PLANT.

One of the latest large manufacturing plants to adopt electrical power transmission is the Keasbey & Mattison Company, makers of the well-known magnesia sectional covering, etc., at Ambler, near Philadelphia. This corporation has just closed a contract with the Mather factories, of Manchester, Conn., for a preliminary plant, consisting of a 60 kilowatt, 220 volt, multipolar generator and four slow-speed motors of 30 horse power capacity and less. One of the motors takes the place of an engine in an isolated department, where steam has been carried by a pipe, covered with the owner's magnesia covering. At the Keasbey & Mattison plant current is also generated for the town lighting circuit. This lighting plant has just been increased by a third Mather ring type dynamo.

THE CURRENT MOTOR COMPANY has been formed at Seattle, Wash., with a capital stock of $4,200, by S. T. Kelsey, Jr., J. M. Tenney, H. L. Reynolds, T. H. Barrow, and others.

NEWS AND NOTES.

DID A TELEGRAPH BLUNDER PROVOKE THE TRANSVAAL RAID?

An ingenious explanation of the action of Dr. Jameson is given by the London correspondent of the "Birmingham Gazette." According to this, Jameson, with his men, were waiting for some word from Johannesburg. It came in a telegram worded thus: "Revolution carried, in compliance with your desire." That was the telegram received. The telegram actually sent from the Johannesburg committee was, "Resolution carried, in compliance with your desire." That "v" instead of "s" made all the difference. Jameson made his plunge into the enemy's country, expecting to find the settlers in arms waiting for his coming. Instead, he found only great masses of armed Boers barring his way. The Boers were fully prepared, and expected his coming. This raises the curious suggestion. Had they anything to do with altering the telegram? Was it a trap for the English raiders to draw them on in order to justify the quaint vulgarism of Krueger that when the tortoise put out its head they would cut it off.

THE STRANDED "ST. PAUL" AS A TELEPHONE STATION.

Racing for home last week, the magnificent American liner, "St. Paul," lost her course in a heavy fog and grounded in the sandy beach at Long Branch. There she has lain ever since, for although several tugs have pulled at her, she can say in the language of her apostolic namesake: "None of these things move me." One of the first ideas that occurred to the parties interested was to keep up communication between ship and shore, and this has been done telephonically, it being the first instance on record where a telephone has been installed on a shipwrecked vessel. A long-distance set has been put on board by the New York and New Jersey Telephone Company, and if you want to talk from New York or Chicago with anybody on the "St. Paul" all you have to do is to call up Long Branch—at least until she moves off and makes her dock.

ELECTRIC HEATING POPULAR.

According to "The Electrical Engineer," the reports are uniformly favorable to the success and desirability of electric heating of street railway cars. This is not only true of the New York City roads which use electric heaters, but is found to be true of roads over the country generally, so far as heard from. Certainly it is true of the local railway's experiment in that line, says the "Springfield Republican," looked at from the passenger's standpoint at least. The cars which employ the new method have never before been so satisfactorily heated as now.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS ISSUED JAN. 28, 1896.

Accumulators:—

SECONDARY BATTERY. P. F. Ribbe, Berlin, Germany, 553,596. Filed July 10, 1895.
A double electrode for storage batteries, composed of two plates of non-conducting material held together by an acid-resisting substance between them, which plates have curved recesses for receiving the active mass.

Alarms and Signals:—

LOW WATER ALARM. O. J. Backus, San Francisco, Cal., 553,636. Filed May 9, 1895.
An expansible bar serves to open or close an electric alarm circuit.

REGISTER. T. B. Dixon, Henderson, Ky., 553,642. Filed Aug. 20, 1894.
Registers the wheels of a train as it passes into a block.

AUTOMATIC REPEATING RAILROAD SIGNAL. R. H. Innes, San Antonio, Tex., 553,733. Filed March 30, 1895.

Dynamos and Motors:—

ARMATURE FOR ELECTRIC MACHINES. R. M. Gardner, Chicago, Ill., 553,557. Filed May 27, 1895.
The purpose of the invention is to avoid possibility of the breaking of the wires which connect the commutator-segments with the armature coils.

CONTROL SYSTEM FOR ELECTRIC MOTORS. G. Sautter, Paris, J. M. H. Savatier and C. E. De Lagabbe, La Seyne, France, 553,819. Filed Sept. 21, 1893.
This invention relates to means for electrically maneuvering armored turrets, guns and ammunition on board ships and in fortified places.

Electrometallurgy:—

ELECTROLYTIC BATH AND APPLIANCE. J. H. George, New York, 553,732. Filed May 8, 1895.
As a new article of manufacture, a sectional bath for holding a solution composed of a homogeneous, flexible and insulated material, provided with a concaved web, and sufficiently rigid to hold the containing solution.

PROCESS OF AND APPARATUS FOR EXTRACTING GOLD FROM ITS ORES. L. Pelatan, Paris, France, and F. Clerici, Milan, Italy, 553,816. Filed June 25, 1895.
Combination of the cyanide and electric process.

Galvanic Batteries:

ELECTRIC BATTERY. J. W. T. Olan, New York, 553,719. Filed Aug. 5, 1892.
The combination with an electric battery, of a source of supply of consumable material therefor, an electromagnet governing said supply, an instrument responding to variations of tension located in multiple arc to the battery circuit, and a circuit breaker for the electromagnet actuated by said instrument, said circuit breaker having adjustable liquid terminals whereby the tension of the battery circuit will be automatically maintained.

Lamps and Appurtenances:—

ELECTRIC ARC LAMP. E. J. Bagnall and G. Arnold, Cleveland, O., 556,637. Filed Oct. 2, 1895.
Provides means whereby to prevent the repeated separations of the carbons, rupturing of the arc, and consequent violent chattering in an alternating current arc lamp.

INCANDESCENT LAMP. H. Green, Hartford, Conn., 553,673. Filed April 16, 1895.
An anchored bent loop filament.

ELECTRIC ARC LAMP. H. O. Swoboda, New York, and E. Lavens, Brooklyn, N. Y., 553,697. Filed Sept. 6, 1894.

Miscellaneous:—

AUTOMATIC COAL RECORDING SYSTEM FOR RAILWAYS. F. A. Walters, Denver, Colo., 553,632. Filed May 23, 1895.
A storage and recording system comprising the receptacle chutes or storage devices of determinate capacity, means for discharging the same, time recording mechanism, etc.

DENTAL LIGHT AND HEATER. F. H. Stafford, Chicago, Ill., 553,572. Filed May 27, 1895.

MANUFACTURE OF VANILLIN. M. Otto and A. Verley, Courbevoie, France, 553,593. Filed July 3, 1895.
The manufacture of vanillin by subjecting a solution of isoeugenate of soda or other base to electrolysis and then treating by means of an acid.

COMBINED FEED-WATER HEATER AND PURIFIER. J. E. Smith, Chicago, Ill., 553,694. Filed June 24, 1895.
A construction wherein is created a galvanic action, to which the feed-water of the boiler is subjected.

Railways and Appliances:—

METHOD OF ELECTRICAL PROPULSION FOR STREET OR OTHER CARS. J. Jackson, Clinton, Ia., 553,529. Filed Nov. 10, 1893.
Details relating to a trolley conduit with insulated main conductors.

ELECTRIC RAILWAY CONDUIT. A. Beck, Atlanta, Ga., 553,552. Filed Nov. 2, 1894.
Details of construction.

UNDERGROUND TROLLEY SYSTEM. N. H. Anspach, Chicago, Ill., 553,635. Filed Aug. 20, 1895.
A conduit structure formed by specially constructed slot rails along the center of a surface track.

ELECTRIC RAILWAY SYSTEM. J. F. Page, Chewacla, Ala., 553,736. Filed June 28, 1895.
In an electric railway, in combination with a series of movable contact plates located along the track and adapted when moved to be connected to the main feed-wire, a motor car having an endless cable connected in circuit with its motor, and adapted to contact with and move said contact plates.

ELECTRIC RAILWAY. M. L. Wood, United States Navy, 553,799. Filed Sept. 12, 1895.
Details relating to a conduit railway.

Switches, Cut-Outs, Etc:—

LIGHTNING ARRESTER. E. G. W. C. Hoffmann, Charlottenburg, Germany, 553,528. Filed Sept. 3, 1895.
A solenoid magnet interposed in circuit with two arrester devices and controlling the arc of the primary arrester device. The secondary arrester has a fusible body interposed between its opposing plates to facilitate the passage of the electrical discharge.

RHEOSTAT. W. H. Morgan, Alliance, O., 553,538. Filed Nov. 21, 1891.
Consists in a base, a resistance medium carried thereby, plates partly embedded in said resistance medium, and a movable contact carried by the base and adapted to engage the plates.

ELECTRIC SWITCH. J. C. Fagan, Watertown, N. Y., 553,730. Filed May 6, 1895.
The object is to provide a simple combined switch and cut-out having the fuses separately covered with refractory material.

Telegraphs:—

TELEGRAPH REPEATER. B. F. Merritt, Newark, N. J., 553,535. Filed May 20, 1895.
In a telegraph repeater, the combination with a pair of polarized relays, of an automatic locking relay having a pair of vibrating levers adapted to move one in the path of the other, a pair of batteries and connections, means carried by said levers to short-circuit the batteries, and contacts for the levers of the polarized relays in said connections.

ELECTROMAGNET. C. D. Haskins, Brooklyn, N. Y., 553,675. Filed May 18, 1889.
An electromagnet with two insulated conductors in concentric sections or helices, each conductor including an inner and outer section or helix. Designed for duplex and quadruplex relays.

Telephones:—

COMPOSITE TELEGRAPHIC AND TELEPHONIC TRANSMISSION. E. E. Backus, New York, 553,605. Filed June 17, 1895.
A telegraphic circuit main line constituting one conductor of a double wire telephone circuit, with a double wire relay, and an induction coil, one winding of both being serially included in the main circuit, and the other winding of the said relay and induction coil being joined up serially in a short closed circuit.

ANTISEPTIC DIAPHRAGM FOR TELEPHONES. E. Weschke, San Francisco, Cal., 553,633. Filed May 9, 1895.
A diaphragm composed of a fabric capable of absorbing an antiseptic, cut into disks of suitable size to fit over the mouthpiece.

REPORTS OF COMPANIES.

STANDARD UNDERGROUND CABLE CO.

The annual meeting of the stockholders of the Standard Underground Cable Company was held at the company's office, Pittsburg, January 28, 1896. Nearly seven-eights of the capital stock of $1,000,000 was represented, either in person or by proxy.

The following gentlemen, all of Pittsburg, were re-elected as directors for the ensuing year, namely, George Westinghouse Jr., president of the Westinghouse Air Brake Company and the Westinghouse Electrical and Manufacturing Company; Robert Pitcairn, Mark W. Watson, J. W. Dalzell, George B. Hill, John B. Jackson, James H. Willock, John Morehead, Jr., and Joseph W. Marsh, the vice president and general manager of the company.

The report of the board of directors showed a total business of nearly $1,000,000 for the year 1895. During the year three quarterly dividends of 1½ per cent. each and one of 2 per cent. were declared, and the remainder of the earnings were carried into surplus account, which now stands at $446,869, notwithstanding the fact that at the beginning of the year 1895 $100,000 was charged off on patent account and $47,000 on account of bad debts, doubtful assets, etc., arising in the first twelve years of the company's existence.

Early in the year 1895 a large two-story and basement building (factory C) was completed and occupied, adjacent to the company's other factories, at the corner of Sixteenth street and Allegheny Valley Railroad, in the heart of the manufacturing district of Pittsburg, and factory B was remodeled into a three-story and basement building, 55x117 feet, of first-class slow-burning construction. The original factory, A, is a large four-story and basement building, and all three factories were equipped during the year with automatic sprinklers, thus greatly reducing insurance premiums, and making a serious fire practically impossible, and so obviating any danger of inability to fill orders on account of fire—an extremely important consideration—where, as in the case of this company, the orders have kept the factory running night and day throughout most of the year.

A large quantity of additional machinery was bought or built and erected in the company's factories during the year, the most important part of which is a moderate-sized but complete modern plant for the manufacture of rubber-covered wires and cables, so that this enterprising company is now prepared to furnish wires and cables of any kind a customer may desire, whether insulated with fiber, paper or rubber. All these improvements, costing between fifty and sixty thousand dollars, were paid for out of the current funds, without contracting any debt whatever on account thereof.

The company carried over into January a large amount of unfilled orders, and the orders booked so far in January have been spread over a wide extent of territory, and the prospects for a large business in 1896 are considered very good.

Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

AN ALTERNATING ARC LAMP.

The General Incandescent Arc Light Company have recently brought out a lamp for alternating currents, which is so up-to-date in every respect that it may well nigh be considered perfect. It is a reflector-plate focusing lamp, keeping the arc in one spot and reflecting the light down. Simplicity, strength and economy are some of its characteristics. It is made in seven different styles, plain or ornamental, wrought iron or polished brass, thus assuring its attractiveness to people of various tastes. The accompanying illustration gives an idea of its general appearance.

Mr. R. B. Corey, 714 Havemeyer Building, New York, is general sales agent for the above company and is thoroughly prepared to supply lamps for every variety of use, as well as the Sun Schmelzer Nurnberg Carbons. He reports the demand for the latter as being unusually large for this time of the year.

PRIOR CLAIMANTS FOR CATHODOGRAPHY.

Note has already been made in these pages of the claims put forward by more than one investigator, to have preceded Professor Roentgen in the discovery of the art of photographing by cathodic or X-rays and of producing "cathodographs." Another claimant, who has more to base his claim on, is Mr. Hans Schmidt in Munich, who sent in for publication last year in "The Photographic Review," a paper which has only just appeared, wherein he maintains that objects and materials which seem impenetrable to light rays are nevertheless not so. He says that the ultra-violet rays in electric light, which do not produce the effect of light on our eyes, pierce through blackened paper, thin wood, India rubber and other materials, while thin layers of metal keep them back. These discoveries in and about the field where Professor Roentgen works will not harm the latter's well-earned fame.

CAMPBELL-ZELL COMPANY'S BOILER CONTRACT.

The Campbell-Zell Company has just secured the contract for the boilers for the Maryland and Columbia railway, the new electric road between Baltimore and Washington. There will be two power-houses, one at Ilchester and another at Hyattsville, each to contain 3,000-horse-power boilers of the Zell improved water-tube safety boilers. The competition for this order was very lively, and the "Zell" was selected only after a careful examination of the points of merit presented. The examination was conducted by experts employed for this purpose.

CHOICE BUFFALO LAND FOR SALE.

Mr. Charles H. Phelps, formerly associated with the old electrical concern of W. H. Gordon & Co., now has an office at 71 Broadway, where he is handling and offering for sale some very desirable Buffalo real estate in what is known as the Kenmore District, between Elmwood and Delaware avenues, and within touch of three trolley lines, one of which runs to Niagara Falls. Tonawanda is close by, and the land lies in the region where Buffalo expects to do her best growing during the next twenty-five years. At present the prices of real estate there are low, in spite of incipient booms, and Mr. Phelps will be glad to see or call on any old electrical friends in order to give them a chance to "get in on the ground floor."

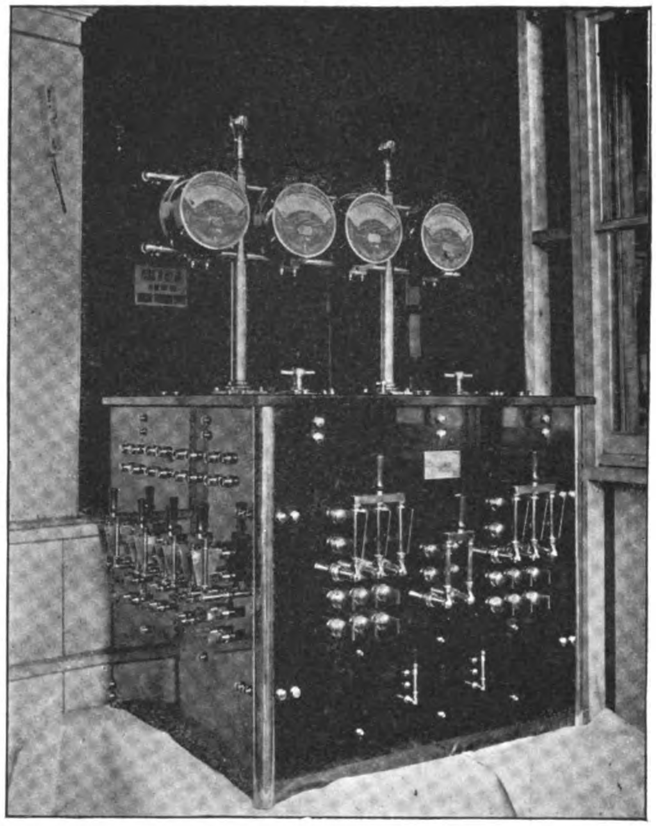
PHILADELPHIA NOTES.

The Apollo Iron and Steel Company, Apollo, Pa., have ordered for their new works at Vandergrift, Pa., three 400 H. P. medium speed "Ball" automatic cut-off side crank engines, direct-connected to Westinghouse generators. The engines are the first of a new line of side crank medium speed engines being brought out by the Ball Engine Company, Erie, Pa., which are especially adapted for direct connection.

THE WARNER SWITCH BOARD.

The accompanying engraving illustrates a new and novel design in switchboard work. It was built by the Electric Engineering and Supply Company of Syracuse for Charles H. Warner, consulting electrical engineer of No. 50 Broadway, New York, and sold through their New York representative, Mr. F. M. Hawkins, of No. 27 Thames street.

The switch board is made of polished black slate, in the form of a cube 3 feet 6 inches by 3 feet 6 inches. The dynamo



THE WARNER SWITCHBOARD.

switches with a capacity of 250 amperes each, are mounted on the front panel and the circuit switches on either side. The bus-bars and all connections are made on the back and inside of the cube, and the dynamo and circuit wires are brought up through the floor inside of the cube.

The top slab carries the rheostat dials and voltmeter switch, as well as the polished brass columns supporting the instruments. The instruments are of the Weston round pattern type and connections to the shunts are brought up through the brass columns, which are made hollow; the wires connecting the pilot lamps on the top of columns are brought up in the same manner.

The edges of the cube are covered by a nicely-polished and lacquered brass moulding.

Access to the interior of the board is had through brass-grilled doors at the rear. The board is placed in the center of a handsome engine-room and presents a remarkably rich and attractive appearance.

A LAMP VALENTINE.

The manufacturers of the Packard lamp recently received from one of their customers an interesting souvenir in the shape of an old, burned-out Packard lamp, together with a valentine card, on which was written: "This lamp has been in constant use for two years and three months." Accompanying the valentine was the following letter:

"Gentlemen—I herewith send you a valentine souvenir which would be a curiosity if placed in your new catalogue. Trusting you may appreciate this little memento and keep it for future reference, we are, very respectfully yours,

"THE CINCINNATI GAS LIGHT AND COKE CO.,
"Electrical Department.
"C. F. Hesser, Vice-President and General Manager."

The Electric Appliance Company has had the souvenir on exhibition at 242 Madison street, where it has attracted considerable attention. A lamp which has burned over 18,000

hours is certainly entitled to more than ordinary respect, even if it does not retain its original efficiency and economy.

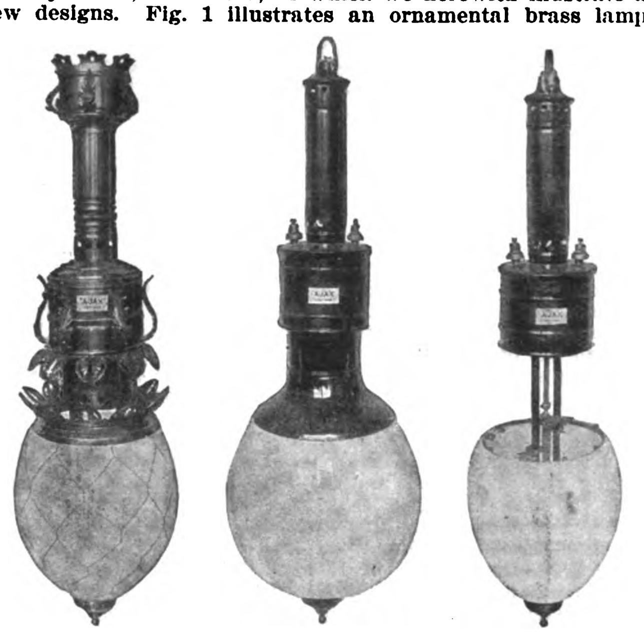
THE SHELDON LABORATORY.

Dr. Samuel Sheldon, of the Brooklyn Polytechnic, announces in our columns this week that he has established a laboratory for special tests, research, etc., where work of such character will be undertaken for public and private clients. The institution is one that we can cordially recommend for patronage to our readers. Dr. Sheldon is a graduate of Middleburg College, where in 1883 he took the highest honors in physics. He was instructor in mathematics there for two years. He then went to Würzburg University (where Prof. Rontgen is now doing his remarkable work in photography with the cathode rays), and was there for three years, acting during two years as assistant to Prof. Kohlrausch. On his return to this country he became assistant to Prof. Trowbridge at Harvard. In the fall of 1889 he was called to the Brooklyn Polytechnic, where he has been ever since as Professor of Physics and Electrical Engineering.

Dr. Sheldon has done wisely in equipping his laboratory with a set of certified copies of the celebrated Reichsanstalt standards, including large compensation apparatus, standard photometer with Heffner-Alteneck lamp, Thomson double bridge for conductivities, small resistances for heavy currents and all sized resistances with Reichsanstalt certificates. He has, of course, also voltmeters, ammeters, etc., of all sizes and kinds in all the standard makes, no expense having been spared to render the equipments for each class of work the most perfect and complete obtainable. Dr. Sheldon is already known as a careful and successful investigator, and it is fortunate that in view of the rapid development of electricity and the allied arts, opportunities for test are rendered so immediately available.

THE VAN NUIS ARC LAMP.

One of the recent additions to the already long list of arc lamps is the "Ajax," manufactured by C. S. Van Nuis, of 136 Liberty street, New York, of which we herewith illustrate a few designs. Fig. 1 illustrates an ornamental brass lamp



FIGS. 1, 2 AND 3.—VAN NUIS ARC LAMPS.

with opal globe and rich cast-brass corona. Fig. 2 illustrates a black japanned case, with round globe and spark arrester, as arranged for outdoor use, the resistance coils being mounted upon porcelain insulators on a detachable frame within the tube at the top of the lamp, making the lamp complete in itself and presenting a compact and neat appearance. Fig. 3 illustrates practically the same lamp as Fig. 2, with the spark arrester removed, showing the type of globe-holder adopted for use with these lamps, which is only one of the many little ingenious devices that enter into the make-up of the Ajax lamp, contributing toward a serviceable and artistic whole.

The regulation is accomplished by a single magnet, which attracts an armature through a long arc and controls at the further end of a rock-shaft a triple movement, which acts upon the rack or upper carbon rod. This triple movement is accomplished in a very ingenious manner by a simply constructed frame and brake-wheel, which, we are told, will admit of the lamp striking approximately a normal arc, and maintaining a uniform candle power throughout the life of the carbons. So far as the simplifying of the controlling movement to a single unit is concerned, the designer of the Ajax lamp has reached that goal; but he has deemed it advisable to introduce the more sensitive triple movement into the feed mechanism, in order to insure a more gradual and delicate adjustment of the arc than could be obtained by applying a simple magnet movement direct.

It is claimed for the "Ajax" lamp that a considerable variation in the governing magnet, due to a sudden rise or fall of potential of the circuit, supplying the lamps, will affect the arc but slightly, because such sudden variation is largely compensated for by the three-fold movement above described. It would appear, therefore, that with a closely regulated circuit the "Ajax" lamp would feed by inappreciable increments, giving an absolutely steady light, and that with an ever-varying potential these fluctuations would be minimized at the arc.

ADVERTISERS' HINTS.

BRUNT AND THOMPSON, East Liverpool, Ohio, are introducing a cleat, which they assert is the most perfect ever manufactured.

THE STANDARD AIR BRAKE COMPANY show a Brill car in one of their "ads" in this number. This car and 180 more on the same road are equipped with their braking apparatus. It is the object of this company to make the use of the "Standard" brake on electric cars as universal as that of the Westinghouse brake on steam cars, and, judging by the present rate of their adoption, it would seem this is not only reasonable, but certain.

THE HESS STORAGE BATTERY COMPANY, Philadelphia, Pa., have some things to say about their double electrode battery, and call attention to the results of a test by Messrs. Houston and Kennelly, proving its efficiency to be of the highest. Send for their interesting catalogue.

THE POPE MANUFACTURING COMPANY is now the Chicago representative of the Calculagraph Co.

THE INDIA RUBBER AND GUTTA PERCHA COMPANY invite any users of their wires and cables to prove they are not what they claim them to be.

THE WESTINGHOUSE MACHINE COMPANY present some very interesting information regarding the selection of materials in building their engines. It is quite sufficient to convince the mose skeptical of the great care taken to produce an engine of the highest grade.

SEVEN MILLION EDISON SOCKETS AND RECEPTACLES are in daily use in the United States. They are manufactured in every conceivable variety by the General Electric Company.

ANOTHER ELECTRIC RAILWAY COMPANY is attesting to the efficiency of the Lombard waterwheel governors.

NINETEEN THOUSAND HOURS OF LIFE is the record of a Packard incandescent lamp. The Electric Appliance Company state that lamps of this make are just as "long" on candle power as they are on life.

"MICANITE" is the insulation used on more than 600 motors of the street railway system of Lynn, Mass.

THE CUTTER ELECTRICAL AND MANUFACTURING COMPANY illustrate several styles of the "I-T-E" automatic magnetic circuit breakers. They are of various designs, especially adapted to the many kinds of service.

BLADE KNIFE SWITCHES are advertised by the Emerson Electric Manufacturing Company. Their latest catalogue and discounts will be mailed on request.

BOWERS BROS., of Chicago, are well qualified to supply anything in the insulating line. Mica is their specialty.

EIMER & AMEND, of New York, are having a lively demand for Roentgen tubes, suitable for photographing invisible objects, a new departure in science which is at present attracting the attention of the whole scientific world. Eimer & Amend are particularly well equipped for this class of work, and maintain a glass-blowing department, so that any desired shape of tube can readily be made to suit the experimenter. They carry also a large stock of induction coils, and the necessary fluorescent salts, and are thus capable of fitting out any laboratory for making these extremely interesting experiments.

THE AUTOMATIC CIRCUIT BREAKER CO., of Newaygo, Mich., reports that its business was double during the month of January that in any month since it started, which ought to demonstrate that its instruments are coming to the front very rapidly. It has never as yet had one of its instruments returned when sent out on approval.

Department News Items wil be found in advertising pages.

THE
Electrical Engineer.

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POWER TRANSMISSION.

WESTINGHOUSE TWO-PHASE POWER PLANT IN THE MILWAUKEE HARVESTER CO'S WORKS.

WHILE electricity has not as yet been applied to agriculture to any great extent, it has recently come one step nearer that field by the installment of a two-phase power transmission plant in the works of the Milwaukee Harvester Company, at Milwaukee, Wis.; and the farmer, as he rides his harvester or mower, may now feel that, while this wonderful agent is not yet directly available for his use, he is at least in close touch with it, and that it has been instrumental in producing cheap machinery for his use.

The Milwaukee Harvester Company started in the Fall of 1881 with 125 men in its employ and an output of 1,200 harvesters and 500 mowers. The business has had a remarkable growth, until at the present time they employ 600 men, and are shipping 12,000 harvesters and 10,000 mowers a year. An idea of the extent of the business may be obtained from the fact that they use 5,000,000 feet of lumber a year, and during the harvesting season ship fifteen carloads of complete machinery a day.

The plant which produces this large output comprises twenty buildings, ranging from one to five stories in height, most of them being of brick, and the whole covering an area of about ten acres. While the management of this company have accomplished much toward reducing the cost of manufacture and increasing the output by strict business organization and putting in operation the piece work system of

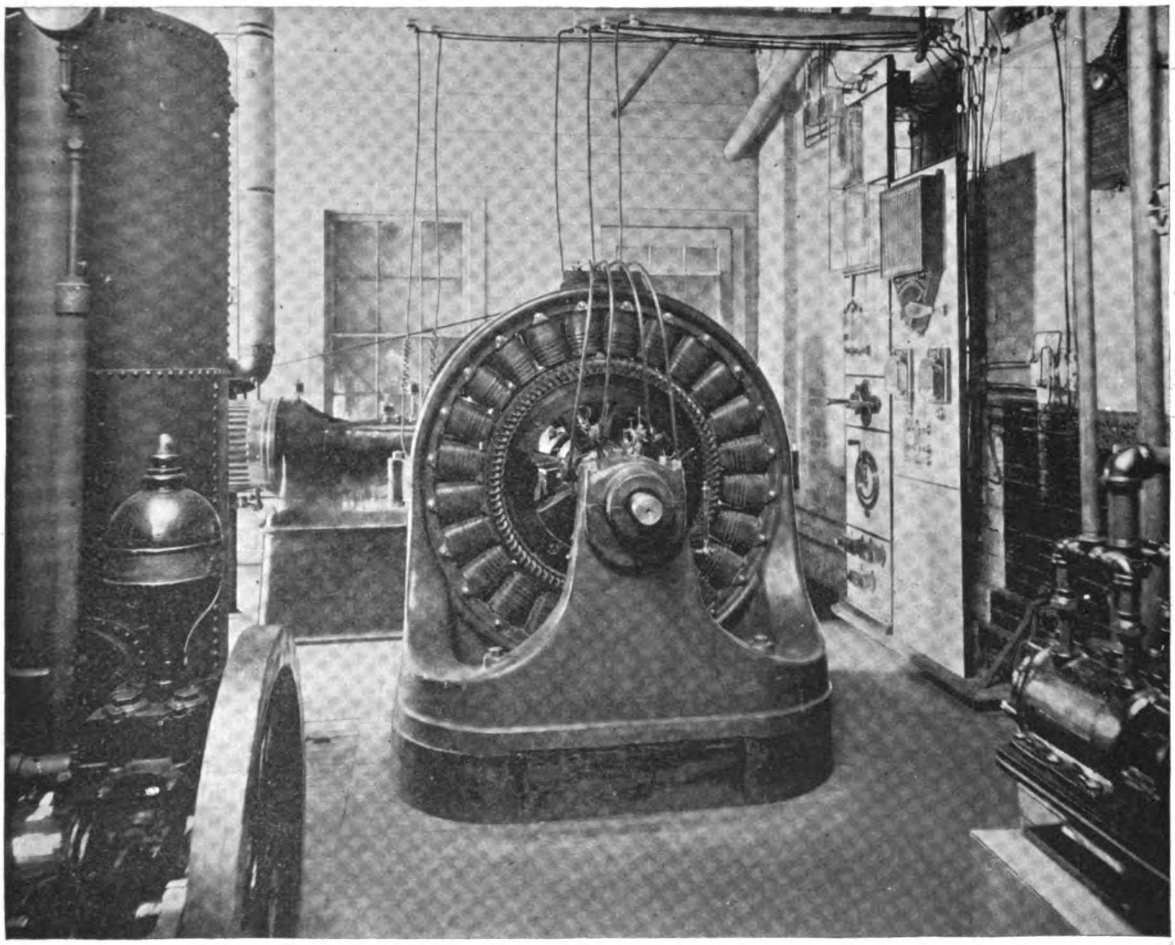


FIG. 1.—WESTINGHOUSE TWO-PHASE POWER PLANT, DRIVEN BY BALL & WOOD ENGINE, IN THE MILWAUKEE HARVESTER WORKS.

labor, and labor-saving machinery, they have realized for some time that they must soon look for some new way of further accomplishing their object—viz., increasing earning power. While they had their men working to the best advantage, while they had the best machinery, good buildings and plenty of power, their method of getting their power to the machines and men was the old one of shafting and belts. They found that as the load on these shafts and belts varied

during the day, their speed, owing to slip, varied greatly, especially at remote points.

With improvement in view, the Manager, Mr. G. H. Schulte, called in Mr. G. G. Armstrong as consulting engineer. After thoroughly canvassing the situation, they decided to put in a complete system of electrical distribution of power, and do away with their old sys-

FIG. 2.—CEILING MOTOR IN OIL AND PAINT HOUSE.

tem of long shafts and belts. After thorough consideration, the polyphase system of the Westinghouse Electric and Manufacturing Company was thought to meet the existing conditions most satisfactorily.

As a sort of preliminary plant, which could be made use of immediately in helping out the old system, and at the same time furnish a good trial as to the reliability and efficiency of the electrical system, it was decided to install a 75-kilowatt generator and use it during the present season, putting in motors wherever they could be made the best use of. Later, if satisfied, they planned to build a new power house and put in a complete system of electrical transmission. The

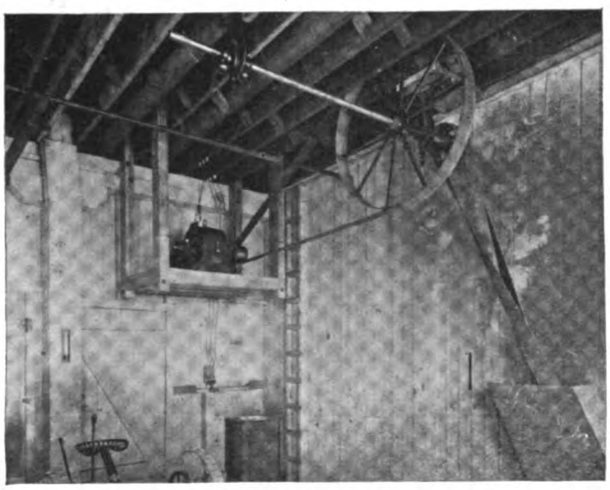


FIG. 3.—MOTOR IN HARVESTER TESTING ROOM.

generating plant illustrated in the engraving, Fig. 1, at present comprises a 75-kilowatt two-phase generator of 7,200 alternations and 440 volts, directly connected to a 125-horse power Ball & Wood engine, running at 300 revolutions per minute. The switchboard and intruments are of the regular Westinghouse type. While the plant is primarily for power work, it is also made use of for furnishing about 220 incandescent lights.

The motors are of various sizes, and are all of the latest non-synchronous type, built by the Westinghouse Company. Wherever they are located in a room where work is being done on the floor, they are suspended from the ceiling by substantial wooden hangers. This not only insures a dry, clean place for the motors, with no danger of anything falling into them, but at the same time has the advantage of taking up no valuable space.

Fig. 2 shows a 10-horse power motor, located in the oil house and used for driving paint grinders and mixers. On account of fire risks this building is located some eighty feet from any other building, and an 80-foot shaft was previously used for conveying the power. This motor carries steadily an overload of 25 per cent., without heating dangerously.

Fig. 3 shows a 5-horse power motor, used in driving the harvester testing room. This motor took the place of 75 feet of shafting, three pulleys and two belts. The saving of power in this case is very evident.

Fig. 4 shows a 20-horse power motor driving the shaft in the mower bar room, and also an elevator, not

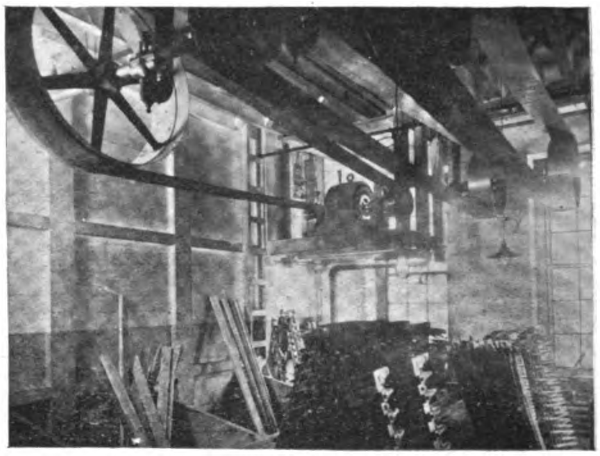


FIG. 4.—20 H. P. MOTOR RUNNING ELEVATOR AND SHAFTING.

shown in the cut. This motor gets rid of 60 feet of shafting. The power used was formerly transmitted through 340 feet of shafting and belting from the engine. A 50-horse power motor is also used, belted to a No. 7 Sturtevant fan, furnishing a blast to two cupolas of thirty tons capacity per day. This fan was formerly driven by a shaft 200 feet long; and the power transmitted through several shops from the engine 520 feet away. The result was that, as the load on the shop varied, the speed of the fan changed, thus giving an irregular blast to the cupolas and badly interfering with the results. With the motor, the speed remains practically constant, and it is found that the same amount of iron can be melted and poured in about one half hour less time than formerly. The importance of this is realized when we consider that this means one-half hour for 125 men, or 62.5 working hours every day; or 18,750 hours per year of 300 days. Taking the average price of labor at twenty cents per hour, this is $3,750 worth more of labor with the same men and the same foundry; while at the same time the product is of a much better quality, due to the iron always being at the proper temperature.

There are several other motors running elevators, shafting, etc., not shown in the cuts. One of these, of

7½-horse power, took the place of 200 feet of shafting and is 520 feet from the engine. The whole plant has been running since being started, some months ago, without an accident of any kind, and is giving great satisfaction.

One great convenience connected with the plant is the ease with which the engineer shuts down and starts up the plant. In shutting down, all switches are left in; in fact, the entire plant is in the same condition as when running. In starting up, the generator is excited and the engine started. This gives a current at low voltage and alternations. The motors immediately start with whatever load is on them, and come right up to speed along with the engine. Thus one man starts and stops the whole plant without any help or any time being lost in going around and starting separate motors, as would be necessary in a direct current system. It will be noted that no use is made of the starting resistances, except when starting a motor with full voltage and alternations on the line, as the motors have a strong starting torque at so low a periodicity.

The management of the company have decided to build a new power house in the Spring, and equip it with high-grade machinery, both steam and electrical. The new building will be of brick 60x120 feet, and located in the centre of the grounds. From this centre, all power will be distributed to motors located in the various departments. This change will be looked forward to with interest, as it is the intention to make it in all respects a model two-phase power plant.

ON THE SUSQUEHANNA.

The Susquehanna Electrical Company has purchased a large island in the Susquehanna River, opposite Peach Bottom, and the Peach Bottom Ferry privileges. The ferry will probably be electrically operated. The company, besides acquiring much land on both sides of the river, has secured five miles of Muddy Creek, from which 2,500-horse power will be derived and used to generate electricity to light Delta and operate the slate quarries.

POWER INCREASE OF THE NIAGARA FALLS PAPER CO.

So successful has been the experience of the Niagara Falls Paper Company in the use of tunnel power that they are about to double their already large plant on the lands of the Niagara Falls Power Company. This paper mill started operations in February, 1894. They have been using 3,000 h. p., while their wheel pit, which is connected with the main tunnel by a lateral, has a capacity of about 8,000 h. p. They will install new turbines to give them 3,000 h. p. additional. This company were the first users of tunnel power, having purchased it undeveloped and excavated their own wheel-pit and lateral connection. The turbines used by them are known as the Geyelin improved inverted Jonval turbines, the product of R. D. Wood & Co., of Philadelphia, Pa., who will make the new wheels.

This latest step on the part of the paper company is one of the most notable that has occurred recently at Niagara, for it means a big increase of an already extensive paper-making plant. The improvements contemplated include a new boiler house, in which 750 h. p. additional will be made available; a new pulp mill with ten more grinders, or an increased capacity of forty tons per day; a new sulphite plant of thirty tons additional capacity, besides other buildings for various purposes. But the company have also been buying up more spruce timber land, and now they hold title to no less than 239,000 acres of the best on the continent. In order that this may quickly and readily be laid down at their mill, they will put in new vessels, so that almost each day will see a vessel-load dispatched to them.

The present buildings of the company do not occupy all the land at their disposal, so that there is ample room for the proposed new structures. Considerable of the machinery has been ordered, and the buildings will soon be commenced.

Naturally, the enlargement will afford work for many men. This departure is most substantial evidence of the great success of the Niagara power development by means of the tunnel. Not a single factory has yet located on the power company's lands but has displayed sufficient foresight to see that ample ground for extensions was available. The advisability and wisdom of this is seen in the present steps to enlarge the paper mill by doubling its capacity. Mr. John C. Morgan is the able manager of this mill, and his plant has been in constant operation since the day it started.

ELECTRIC POWER ON THE MAN OF WAR "BROOKLYN."

The "Brooklyn," following the recommendation of Captain Sampson, approved by the Secretary, will have electrical turning gear in half her turrets and steam gear in the others, in order to test the two by comparison.

The French turrets on the Canet electric system, recently illustrated in "The Electrical Engineer," are said to work very well, and they have besides safety gear a system of counter weights to provide for the automatic return of lever handles. In order, also, to provide for accidents, they are supplied with a supplementary hand gear. It is said that about forty Canet turrets worked by electricity have been turned out for different ships, or are now in progress, among the vessels supplied with them being the Chilian Capitan Prat and the Danish coast defender Skjold. The work has been perfected so that comparatively small powers are required for turning the turrets. England's Powerful and Terrible have electrically-worked barbette mounts for their 9.2-inch guns.

One stimulus to the introduction of electrical instead of hydraulic machinery for turret turning has been the liability of the latter to suffer in winter from the freezing of the water. This liability was illustrated recently in the case of one of our own second-class battleships. Russia, which is naturally interested very much in this matter, in relation to her Baltic fleet, has adopted the device of running steam pipes along the side of the hydraulic pipes, so that the water in the latter is prevented from freezing. Great Britain also took up this system, beginning with the Empress of India, and it may be adopted in our own ships.

THE NEW PHOTOGRAPHY.

(Professor Roentgen, of Würzburg, has discovered how to photograph through a person's body, giving a picture only of

O, Roentgen, then the news is true,
  And not a trick of idle rumor,
That bids us each beware of you,
  And of your grim and graveyard humor.

We do not want, like Dr. Swift,
  To take our flesh off and to pose in
Our bones, or show each little rift
  And joint for you to poke your nose in.

We only crave to contemplate
  Each other's usual full-dress photo;
Your worse than "altogether" state
  Of portraiture we bar in toto!

The fondest swain would scarcely prize
  A picture of his lady's framework;
To gaze on this with yearning eyes
  Would probably be voted tame work!

No, keep them for your epitaph,
  These tombstone souvenirs unpleasant;
Or go away and photograph
  Mahatmas, spooks, and Mrs. Besant.

—London "Punch."

THE ELECTRICIAN IN WARFARE.

At the last general meeting of the London Institution of Electrical Engineers, the president, Dr. John Hopkinson, F. R. S., referred to the recent international complications, and advised that electrical engineers should place their technical knowledge at the service of their country for the purpose of national defense. He said that their services would be invaluable in the matter of military telegraphs, submarine mining, electrical sighting of guns and searchlights. A committee was appointed to ascertain the number of engineers who were willing to enroll and to inquire as to methods in which their services could be utilized.

AN ELECTRIC COAT.

Major A. H. Swanson, of Texas, where they are supposed not to need such things, suggests that motormen can be kept warm in winter by hitching the trolley circuit on to their overcoats, which have a resistant network of wire imbedded in them, and thus warm up. This is something like the idea that has been practically carried out in the "Electrotherm."

ELECTRIC LIGHTING.

DIELECTRIC STRENGTH OF OILS UNDER ALTERNATING POTENTIALS.

BY PROF. ELIHU THOMSON.

IN the course of tests made under the direction of the writer some two or three years ago, the interesting fact was noticed that the striking distances of high potentials in insulating oils were in some way variable with the frequency of the current or potential waves, or upon the time during which electric stresses existed in a given direction through the medium.

This relation has been confirmed by other and later experiments. The general effect was found to be that discharges at low frequencies are capable of puncturing mineral oil layers up to from one-third to one-half the thickness of an air layer required to just resist puncture by the same discharges, while with high frequencies of equal striking distance in air, an oil layer of one-thirtieth to one sixtieth of the thickness of the air layer was sufficient to prevent discharges. At frequencies such as 125 per second, a potential which would give one-half inch spark in air, may puncture from one-third to one-fourth inch of oil between the electrodes, while at frequencies of 50,000 to 100,000 a layer of oil of one-fourth inch may resist puncture when the spark in air is as much as eight inches. The high frequencies experimented with were such as are given by condenser discharges over an air gap, including a primary of a few turns, with a secondary of a single layer of some hundreds of turns immersed in oil. The discharges, in such cases, are not continuous waves, but a rapid succession of oscillatory discharges with dead intervals or periods of inactivity intervening.

The effect of carefully drying an oil was found to increase its insulating power. This was also true to a marked extent when careful filtering was resorted to, a decided decrease of striking distance through the oil with the lower frequencies being observed. It follows from this that all oil used in insulating for high potentials with low frequencies should be kept clean and homogeneous, and free from floating particles.

Variations of temperature of oil did not, in the experiments made, greatly affect the striking distances for a given potential. The general fact, however, that with high frequencies the insulating power of oil layers is, as measured by the striking distance in air relatively to that in the oil, far in excess of such insulating power for low frequencies, seems to be unaffected by the dryness, clearness or temperature of the oil used.

It appears probable, also, that with partially conducting liquids like alcohol and water the behavior with high frequencies is more like that of a true dielectric insulator than with low frequencies. As an interesting fact in this connection it may be noted that a high potential high frequency coil capable of yielding spark torrents over thirty inches of air gap between its terminals, still maintains its discharges even when shunted by a glass tube one and a half inches in diameter containing ordinary water, and long enough to bridge the gap.

It is difficult to account for the differences in the effects obtained with high frequencies from those with low frequency alternating waves. A time lag in the establishment of the full dielectric stress or full electrostatic field in the oil might account for the phenomena. According to this hypothesis if two electrodes under oil, separated a certain distance, instantly acquire a difference of potential this potential would not with equal rapidity strain the oil to the full extent. It might be assumed that the polarization of the oil molecules requires time; or, it may be that only such part of the electrostatic field as is due to the ether is first established after electrification and that the increase of such field, due to the molecules of the substance, such as the interposed oil, is subsequent to the former.

If this were so the establishment of an electrostatic field at high rates in oils would present analogies with the case of magnetic fields in iron or metals.

It would also follow, if the supposition of a lag as above be true, that in condensers such as those using oil as a dielectric, the capacity would be less the higher the frequency. Again, if any such lag as is assumed exists, it would probably vary with different insulating media, and it may depend upon the molecular state, as viscosity, for example. Observations of the oil space between the immersed electrodes by polarized light could probably be used with certain media to detect any differences in time of establishment of electrostatic stress with different frequencies, it being well known that under high stresses certain insulating liquids become strongly affected in their optical properties, with rotation of polarized beams of light traversing them. If the optical effect noticed should be less in the case of high frequencies than with low rates it would indicate a probable lag of the kind assumed. Similar studies using solid dielectrics like glass, mica, etc., would also be desirable. Should the results be negative it would be necessary to attack the problem in some other way.

M. P. Jaret, about a year or more ago, in a communication to the Paris Academy of Sciences, gave the results of his investigation of the properties of mica. He found that it did possess, with rapid oscillations, what might be termed a dielectric hysteresis. Such a property may exist to a more marked degree in oils.

In the tests of the power of oil layers to withstand puncturing by high potentials a curious effect was noticed, which was that discharges under oil passed far more readily between balls than between sharp points. In other words, with any given difference of potential between the immersed electrodes, as measured by the air spark obtainable, pointed electrodes could be brought much nearer than balls without provoking puncture. With balls of one-half inch diameter as terminals and with low frequency (125), potential differences, ranging from 100,000 to 150,000 volts, the space between the points could be one quarter that between the balls. The ratio between the length of spark in air and between sharp points in oil was 10 to 1 at 10,000 volts and 8 to 1 at 15,000, while with balls these ratios fell to 2.4 to 1 and 2 to 1, respectively. When flat plates were substituted for the balls the striking distance in oil was still further increased as compared with the distance with points. The seemingly anomalous action of points under oil, so different from their action in gases or air, is certainly curious, and the usual injunction to avoid points and edges as conducive to electric discharge does not seem to apply in such media as oil, at least when the potentials are alternating and at ordinary frequencies.

In experimenting with discharges in oil uniform results are only to be obtained by using carefully filtered oil, as ordinarily they contain suspended particles, fibers, etc., which appear to bridge the space between the electrodes and provoke a breakdown due to the

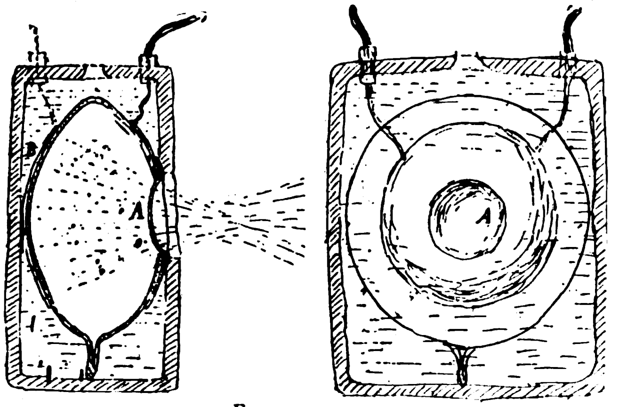
non-homogeneous character of the dielectric. It is also necessary to discard oil after arcing has once occurred through it, as it will have become much weaker owing doubtless to the fine carbon particles set free and which remain floating ready to be drawn into the space between the electrodes, thus giving rise to loss of homogeneity of the medium.

CATHODOGRAPHIC EXPERIMENTS.

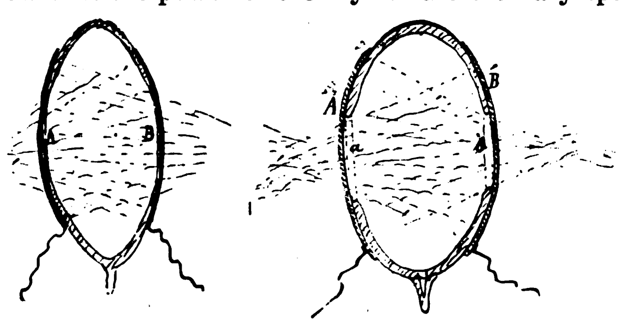
BY

Elihu Thomson

I WAS much pleased to find in your issue of Feb. 5 such complete accounts of cathode ray experiments and similar phenomena. It would certainly appear from what has been published that similar effects are possible to be obtained without the use of Crookes' tubes, but I may be pardoned for calling attention to the fact that we can hardly expect any activity in the solar rays, for the reason that such rays as reach us have passed a great depth of air the absorptive power of which, for cathode rays, would probably be quite sufficient to prevent their manifesting themselves at any point on the earth's surface, and, besides, to keep photographic plates as they are kept would be impossible. I am inclined to favor the hypothesis which has been attributed to Lenard, that the cathode rays are simply invisible rays far beyond the violet end of the spectrum—ether waves of very short wave length. We know that the power of the rays of the ordinary spectrum to affect silver salts is most marked at the upper end of the spectrum, and that such power is possessed by rays far beyond the visible spectrum. Violet rays have magnetic properties, as is well known, and cathode rays as they appear in the Crookes tube are deflected by a magnetic field. There is, then, apparently a relationship between magnetism and both ordinary violet light and cathode rays which with the cathode rays involve a displacement of the beam by magnetism, while with other waves of lower pitch, approaching the visible spectrum, such displacement might become infinitesimal, or too small to be measurable.



FIGS. 1 AND 2.



FIGS. 3 AND 4.

I may suggest, in this connection, an apparatus which ought to be capable of developing cathode rays of great power when excited by high frequency currents of high potential. It consists mainly of a glass vessel shown in section in Fig. 1, formed like a flattened sphere or oblate spheroid, and having an opening at A which is covered by a thin aluminum cap, as indicated, which is covered at the opening, A, and fits over the exterior of the glass vessel, being securely cemented thereto. This cap or aluminum cover is made as thin as possible consistent with proper strength to resist the pressure of the atmosphere. It forms not only a window for the escape of the cathode rays, but also a metallic conducting coating which is to be connected to one of the wires furnishing discharges for exciting the apparatus. The other coating is directly opposite and is seen at B, and is an exterior covering on the glass attached to the other terminal of the electric source. The concavity of B would be made such that the cathode rays leaving the same would be concentrated through the opening covered by A. The apparatus so prepared would be exhausted to the proper Crookes' vacuum and sealed.

In order that the excitation may be pushed without overheating; and in order, also, that the discharges should not traverse the cover of the bulb of glass, it would be advisable to immerse such a bulb in oil, particularly when it is subjected to the most vigorous excitation. To do this it would be only necessary to inclose it, as indicated in the sketches, in a box of hard rubber or wood filled with oil and having openings for the passage of the terminals, as far apart as possible. In order, also, to prevent the possibility of any oil layer obscuring the rays there would be a seal around the opening or window A, thus permitting the rays to pass freely into the atmosphere. A circulation of oil in case of heating would be easy to maintain and the apparatus could therefore be kept comparatively cool. Figs. 3 and 4 show evident modifications of such an apparatus. In Fig. 3 the glass should be made as thin as possible opposite the positions A and B, and then these portions are covered with aluminum caps cemented on and fitting as closely to the glass as possible. In this case the rays would emanate from both sides under high frequency excitation. In Fig. 4 the only difference in the structure would be that the glass would be cut away at A and B so as to give a double window, while the aluminum caps extending far from the openings are, as before, the electrodes. In this case the rays would emanate from both sides of the apparatus with equal facility under high frequency alternating currents.

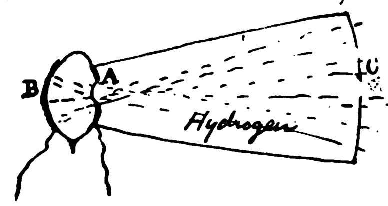


FIG. 5.

It would, of course, be possible to use perfectly spherical bulbs in such structures as Figs. 3 and 4, and this would conduce to cheapness of construction, as it would then only be necessary to prepare a bulb exhausted to a Crookes' vacuum, and use it entirely without internal electrodes, if desired. I have no doubt

that by carefully selecting incandescent lamps in accordance with the vacuum which they contain, and which is frequently a Crookes vacuum, they could be used as cathode ray generators by putting on two thin aluminum cups on opposite sides of the bulb which are made the terminals of a high frequency apparatus.

In order that the shadow pictures produced by cathode rays shall be as sharp and perfectly defined as possible, the rays themselves should emanate from a spot some distance away from the object, the shadow of which is to be cast upon the sensitive plate, and the further away the better, but, of course, the rays become less effective at the increased distance, as do rays of light, and they are also absorbed by the air layer and thus undergo a further diminution of activity. Lenard found that the cathode rays passed through a vacuous chamber quite freely, and that they were conveyed with less loss through hydrogen than through air. It would, therefore, seem that the cathode ray generator could most effectively work at a distance by interposing a tube or cylinder containing hydrogen gas, or, in other cases, a vacuum chamber; if the ray generator is to be placed at any considerable distance from the objects. This is illustrated in Fig. 5, where A B is the cathode ray generator inclosing a Crookes vacuum, and from A to C is the chamber filled with hydrogen gas, while the object the shadow of which is to be thrown upon the sensitive plate would be placed beyond C, and, lastly, the plate beyond the object itself.

The above suggestions are made for the purpose of assisting experimentation in this field on the part of those who will undoubtedly take up the work, and with the object of utilizing large amounts of energy in the production of cathode rays.

I might add that I made some experiments which have succeeded in yielding a picture of a number of coins, or rather coin shadows, on the sensitive plate. The coins were separated from the plate by a single thickness of black paper, and above the coins two thicknesses of heavy pasteboard, perfectly opaque to ordinary light, existed. The Crookes' tube was supported about 4 inches above the pasteboard, and excited by one of my higher frequency coils adjusted to a spark of about two inches or more. The exposure or excitation of the Crookes' tube lasted about seven or eight minutes, resulting in the production of a negative quite dense enough to print from.

KILLED WHILE STEALING LIVE WIRE.

While stealing fully-charged electric light wires in Newark last week, a man named J. B. Gove received a shock while on a pole twenty-five feet above the sidewalk and fell. His skull was fractured and he died instantly. A companion engaged with him in the thefts disappeared. His identity is unknown.

The two men were thoroughly equipped as linemen, and early in the night stopped with a horse and wagon, which contained a ladder, some tools and a quantity of wire, in front of No. 298 Belleville avenue. They took the ladder to a pole and Gove ascended.

He had cut one strand and was working on another when he gave a cry, threw up his hands and fell head foremost, landing on the block pavement. The other man ran to him, seemed to realize that he was dead, took Gove's watch from his pocket, jumped into the wagon, lashed the horse and drove away before the astonished onlookers could interfere.

A physician and policeman were summoned, and an examination showed that Gove's left hand had been badly burned by the wire. His skull was fractured and his legs and other bones in his body were broken. It was learned that Gove formerly worked as a lineman in Atlantic City.

JACKSONVILLE FLA.—Adams & Richardson are now doing their refrigeration by electricity, a twelve-horse power motor having been recently installed in their place by Johnson Law.

MR. EDISON'S EXPERIMENTS WITH X-RAYS.

It is safe to say that there is probably no one possessed of a vacuum tube and an induction coil, who has not undertaken to repeat Professor Roentgen's experiments in obtaining shadow photographs, or cathodographs, as they have been called, while those who

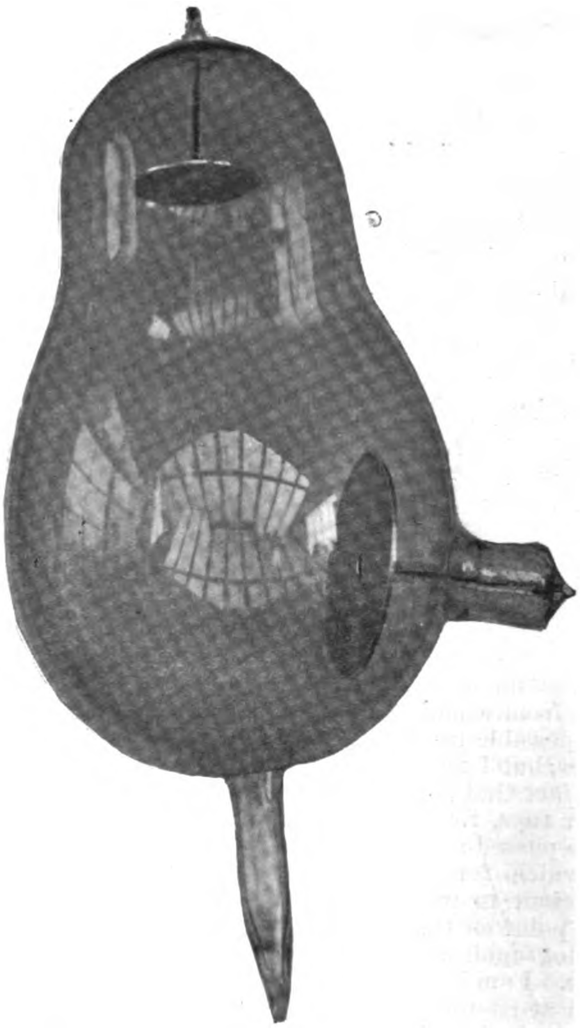


FIG. 1.—VACUUM BULB MADE FROM INCANDESCENT LAMP; USED BY MR. EDISON FOR OBTAINING THE RÖNTGEN EFFECTS.—FULL SIZE.

are fortunate enough to possess larger facilities for experimentation have taken up the work enthusiastically. Among the latter is Mr. Edison, who, with his characteristic energy, and fertility of invention, has already placed at the disposal of future experimenters some facts which cannot fail to be of value in the prosecution of research in this direction.

Before proceeding further it may be well to state that Mr. Edison considers the X-rays more in the light of static thrusts than of undulatory propagations, and that their effects on the sensitive photographic film are due rather to direct mechanical than to chemical action. He cites as an analogy the power of a tuning fork, of certain pitch, to detonate iodide of nitrogen when brought near the latter.

Regarding the construction of the tubes for producing the X-rays Mr. Edison differs from many experimenters in this field, who hold that a high vacuum is necessary to obtain the effects. In proof of his contention Mr. Edison has made quite a large number of experiments, which go to prove that the vacuum

required is largely dependent upon the potential available; thus, in his own experiments, in which he has employed a coil giving a 4-inch spark, he finds that the best point at which to seal off the lamp from the pump is that at which all glow within the interior of the lamp ceases, and fluorescence of the glass alone is observed.

The vacuum tube employed by Mr. Edison, which is illustrated in Fig. 1, is made from the bulb of an ordinary 16-c. p. lamp, into the top of which is fused a platinum wire, carrying a disk $\frac{3}{4}$ of an inch in diameter, made of polished aluminum. At the side of the lamp bulb there is fused in the cathode terminal, consisting of a disk $1\frac{1}{4}$ inches in diameter, also made of polished aluminum, but placed at right angles to the upper disk. The object of this arrangement, of course, is to allow the cathode rays to be thrown off and to act upon interposed objects, without interference from the anode terminal. By employing an incandescent lamp bulb, the thickness of which is only 1/64 of an inch, Mr. Edison finds that the interference due to the intervening glass is very small, as compared with that of the Crookes tubes, which are in general use.

Mr. Edison, as will be seen, employs anode disks, instead of the simple platinum wire terminals, for the reason that the disk keeps cool, even under continuous use of the vacuum bulb, whereas the platinum wire

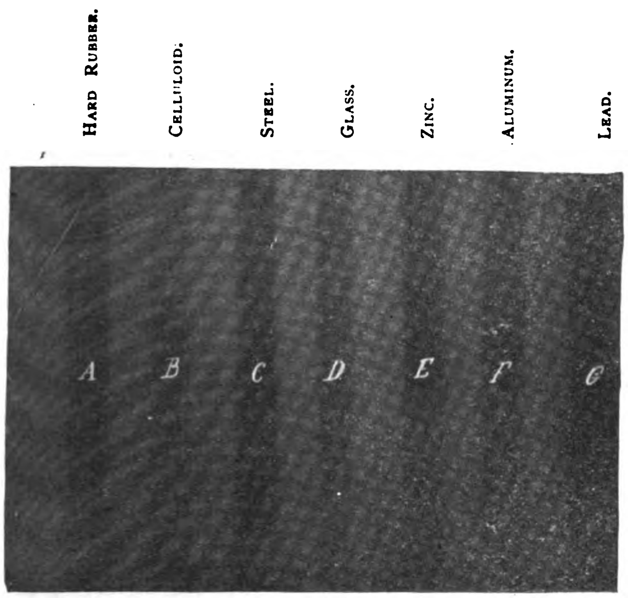


FIG. 2.—CATHODOGRAPH PRINT SHOWING VARYING PERMEABILITY OF DIFFERENT SUBSTANCES TO THE X-RAYS.

has been found to heat greatly, and to interfere with the results. Besides aluminum disks, Mr. Edison has also tried carbon, which he finds will permit of almost any amount of current being sent through the bulb, but for some, as yet unexplained, reason the carbon disks appear to offer a tremendous internal resistance, and become white hot, so that they cannot be employed for the purpose, and all Mr. Edison's experiments have thus far been made with aluminum disks as terminals.

Through the courtesy of Mr. Edison we were permitted to witness the exhaustion of the bulbs, in the pump room of the Edison laboratory, and as the process may be of interest to others experimenting in this line, we deem it well to give it in some detail. The bulb is put on the pump, and immediately below is placed a ring carrying a large number of small gas jets, so placed as to heat the bulb during the first stages of the process of exhaustion. This heat is necessary in order to drive out the air, which is condensed on the interior wall of the glass bulb, and which cannot be gotten rid of by any amount of exhaustion, and if not expelled by heat is always sure to give trouble as soon as the lamp is taken off the pump.

While the exhaustion is being carried on Mr. Edison passes through the bulb the discharge from an induction coil, giving a 4-inch spark, the primary of which is fed by six storage cells, and the circuit broken by a solid break-wheel, giving 100 breaks per second. This break-wheel consists of a solid brass disk, $\frac{1}{4}$ of an inch thick, with the teeth so arranged that the period of closure of the circuit is twice that of opening. Across the make and break terminals Mr. Edison inserts an 8-microfarad condenser.

The lamp being mounted and the pump started, the first phenomenon observed is a thin stream of purplish sparks between the terminals, which stream gradually becomes thicker and thicker in form, resembling a band. This discharge passes merely from the edge of one disk to that of the other. The next prominent change, as the exhaustion proceeds, is the appearance of a violet glow around the upper electrode, and a similar glow over a part of the surface of the lower terminal; this finally increases until both terminals are surrounded by the glow which gradually increases until the whole bulb is filled with the glow which becomes lighter and lighter in color, approaching to a milky whiteness. This continues for about a minute, when a dark space begins to form upon the lower terminal, increasing in size until finally the whole interior of the bulb becomes dark, and the glass alone fluoresces. It is immediately after this stage is reached that Mr. Edison finds it most advantageous to seal off the bulb of the pump, having in view the size of the bulb employed by him, and the potential employed. In order to obtain the vacuum just described, in bulbs of the size indicated, only from eight to ten minutes are required. Where higher exhaustion is employed higher potential must, according to Mr. Edison, be used, in order to effect the same results; but, as Mr. Edison points out, a bulb in connection with a 3-inch spark coil need only to be exposed a correspondingly longer time in order to effect the same photographic results as a bulb operated at higher potential.

Mr. Edison has thus far only experimented with bulbs containing atmospheric air, but expects shortly to fill the bulb with hydrogen and exhaust it, and believes that it will prove to be a more sensitive vacuum, and to show an increase in the effect sought for.

Among the interesting work already accomplished by Mr. Edison is that shown in the engraving, Fig. 2, made directly from a plate taken by means of the Roentgen X-rays, in Mr. Edison's laboratory. These represent the print obtained by the rays passing through various substances, which are designated by the letters marked upon the strips as follows: A, hard rubber; B, celluloid; C, steel; D, glass; E, zinc; F, aluminum; G, lead. These strips were all of the same size, about $\frac{1}{8}$ of an inch thick, so that a comparison can be made as to the permeability to passage of the various materials to the X-rays. Thus, it is curious to note that the best of all is celluloid, which seems to offer very little resistance to the path of the rays, while glass shows almost as much opacity to the rays as steel.

Besides the handiness of the form of bulb used by Mr. Edison, it has another quality to recommend it, namely, its cheapness. It is evident that such vacuum bulbs could be made and sold at a profit for 50 cents.

ON A NEW KIND OF RAYS.[1]

(1) A DISCHARGE from a large induction coil is passed through a Hittorf's vacuum tube, or a well-exhausted Crookes' or Lenard's tube. The tube is surrounded by a fairly close-fitting shield of black paper; it is then possible to see, in a completely darkened room, that paper covered on one side with barium platinocyanide lights up with brilliant fluorescence when brought into the neighborhood of the tube, whether the painted side or the other be turned towards the tube. The fluorescence is still visible at two metres distance. It is easy to show that the origin of the fluorescence lies within the vacuum tube.

(2) It is seen therefore that some agent is capable of penetrating black cardboard, which is quite opaque to ultra-violet light, sunlight or arc-light. It is therefore of interest to investigate how far other bodies can be penetrated by the same agent. It is readily shown that all bodies possess this same transparency, but in very varying degrees. For example, paper is very transparent; the fluorescent screen will light up when placed behind a book of a thousand pages; printer's ink offers no marked resistance. Similarly the fluorescence shows behind two packs of cards; a single card does not visibly diminish the brilliancy of the light. So, again, a single thickness of tinfoil hardly casts a shadow on the screen; several have to be superposed to produce a marked effect. Thick blocks of wood are still transparent. Boards of pine two or three centimetres thick absorb only very little. A piece of sheet aluminum, 15 mm. thick, still allowed the X-rays (as I will call the rays, for the sake of brevity) to pass, but greatly reduced the fluorescence. Glass plates of similar thickness behave similarly; lead glass is, however, much more opaque than glass free from lead. Ebonite several centimetres thick is transparent. If the hand be held before the fluorescent screen, the shadow shows the bones darkly, with only faint outlines of the surrounding tissues.

Water and several other fluids are very transparent. Hydrogen is not markedly more permeable than air. Plates of copper, silver, lead, gold and platinum also allow the rays to pass, but only when the metal is thin. Platinum .2 mm. thick allows some rays to pass; silver and copper are more transparent. Lead 1.5 mm. thick is practically opaque. If a square rod of wood 20 mm. in the side be painted on one face with white lead, it casts little shadow when it is so turned that the painted face is parallel to the X-rays, but a strong shadow if the rays have to pass through the painted side. The salts of the metals, either solid or in solution, behave generally as the metals themselves.

(3) The preceding experiments lead to the conclusion that the density of the bodies is the property whose variation mainly affects their permeability. At least no other property seems so marked in this connection. But that the density alone does not determine the transparency is shown by an experiment wherein plates of similar thickness of Iceland spar, glass, aluminum, and quartz were employed as screens. Then the Iceland spar showed itself much less transparent than the other bodies, though of approximately the same density. I have not remarked any strong fluorescence of Iceland spar compared with glass (see below, No. 4).

(4) Increasing thickness increases the hindrance offered to the rays by all bodies. A picture has been impressed on a photographic plate of a number of superposed layers of tinfoil, like steps, presenting thus a regularly increasing thickness. This is to be submitted to photometric processes when a suitable instrument is available.

(5) Pieces of platinum, lead, zinc and aluminum foil were so arranged as to produce the same weakening of the effect. The annexed table shows the relative thickness and density of the equivalent sheets of metal:

	Thickness.	Rel. Thickness.	Density.
Platinum	.018 mm.	1	21.5
Lead	.050 „	3	11.3
Zinc	.100 „	6	7.1
Aluminum	3.500 „	200	2.6

From these values it is clear that in no case can we obtain the transparency of a body from the product of its density and thickness. The transparency increases much more rapidly than the product decreases.

(6) The fluorescence of barium platinocyanide is not the only noticeable action of the X-rays. It is to be observed that other bodies exhibit fluorescence, e. g. calcium sulphide, uranium glass, Iceland spar, rock-salt, etc.

Of special interest in this connection is the fact that photographic dry plates are sensitive to the X-rays. It is thus possible to exhibit the phenomena so as to exclude the danger of error. I have thus confirmed many observations originally made by eye observation with the fluorescent screen. Here the power of the X-rays to pass through wood or cardboard becomes useful. The photographic plate can be exposed to the action without removal of the shutter of the dark slide or other protecting case, so that the experiment need not be conducted in darkness. Manifestly, unexposed plates must not be left in their box near the vacuum tube.

It seems now questionable whether the impression on the plate is a direct effect of the X-rays, or a secondary result induced by the fluorescence of the material of the plate. Films can receive the impression as well as ordinary dry plates.

I have not been able to show experimentally that the X-rays give rise to any calorific effects. These, however, may be assumed, for the phenomena of fluorescence show that the X-rays are capable of transformation. It is also certain that all the X-rays falling on a body do not leave it as such.

The retina of the eye is quite insensitive to these rays; the eye placed close to the apparatus sees nothing. It is clear from the experiments that this is not due to want of permeability on the part of the structures of the eye.

(7) After my experiments on the transparency of increasing thicknesses of different media, I proceeded to investigate whether the X-rays could be deflected by a prism. Investigations with water and carbon bisulphide in mica prisms of 30° showed no deviation either on the photographic or the fluorescent plate. For comparison, light rays were allowed to fall on the prism as the apparatus was set up for the experiment. They were deviated 10 mm. and 20 mm. respectively in the case of the two prisms.

With prisms of ebonite and aluminum, I have obtained images on the photographic plate, which point to a possible deviation. It is, however, uncertain, and at the most would point to a refractive index 1.05. No deviation can be observed by means of the fluorescent screen. Investigations with the heavier metals have not as yet led to any result, because of their small transparency and the consequent enfeebling of the transmitted rays.

On account of the importance of the question it is desirable to try in other ways whether the X-rays are susceptible of refraction. Finely powdered bodies allow in thick layers but little of the incident light to pass through, in consequence of refraction and reflection. In the case of the X-rays, however, such layers of powder are for equal masses of substance equally transparent with the coherent solid itself. Hence we cannot conclude any regular reflection or refraction of the X-rays. The research was conducted by the aid of finely-powdered rock-salt, fine electrolytic silver powder, and zinc dust already many times employed in chemical work. In all these cases the result, whether by the fluorescent screen or the photographic method, indicated no difference in the transparency between the powder and the coherent solid.

It is, hence, obvious that lenses cannot be looked upon as capable of concentrating the X-rays; in effect, both an ebonite and a glass lens of large size prove to be without action. The shadow photograph of a round rod is darker in the middle than at the edge; the image of a cylinder filled with a body more transparent than its walls exhibits the middle brighter than the edge.

(8) The preceding experiments, and others which I pass over, point to the rays being incapable of regular reflection. It is, however, well to detail an observation which at first sight seemed to lead to an opposite conclusion.

I exposed a plate, protected by a black paper sheath, to the X-rays, so that the glass side lay next to the vacuum tube. The sensitive film was partly covered with star-shaped pieces of platinum, lead, zinc and aluminum. On the developed negative the star-shaped impression showed dark under platinum, lead, and, more markedly, under zinc; the aluminum gave no image. It seems, therefore, that these three metals can reflect the X-rays; as, however, another explanation is possible, I repeated the experiment with this only difference, that a film of thin aluminum foil was interposed between the sensitive film and the metal stars. Such an aluminium plate is opaque to ultra-violet rays, but transparent to X-rays. In the result the images appeared as before, this pointing still to the existence of reflection at metal surfaces.

If one considers this observation in connection with others, namely, on the transparency of powders, and on the state of the surface not being effective in altering the passage of the X-rays through a body, it leads to the probable conclusion that regular reflection does not exist, but that bodies behave to the X-rays as turbid media to light.

Since I have obtained no evidence of refraction at the surface of different media, it seems probable that the X-rays move with the same velocity in all bodies, and in a medium which penetrates everything, and in which the molecules of bodies are embedded. The molecules obstruct the X-rays, the

1. By W. C. Röntgen. Translated by Arthur Stanton from the Sitzungsberichte Würzburger Physik-Medic. Gesellschaft, 1895.

more effectively as the density of the body concerned is greater.

(9) It seemed possible that the geometrical arrangement of the molecules might affect the action of a body upon the X-rays, so that, for example, Iceland spar might exhibit different phenomena according to the relation of the surface of the plate to the axis of the crystal. Experiments with quartz and Iceland spar on this point lead to a negative result.

(10) It is known that Lenard, in his investigations on kathode rays, has shown that they belong to the ether, and can pass through all bodies. Concerning the X-rays the same may be said.

In his latest work Lenard has investigated the absorption coefficients of various bodies for kathode rays, including air at atmospheric pressure, which gives 4.10, 3.40, 3.10 for 1 cm., according to the degree of exhaustion of the gas in discharge tube. To judge from the nature of the discharge, I have worked at about the same pressure, but occasionally at greater or smaller pressures. I find, using a Weber's photometer, that the intensity of the fluorescent light varies nearly as the inverse square of the distance between screen and discharge tube. This result is obtained from three very consistent sets of observations at distances of 100 and 200 mm. Hence air absorbs the X-rays much less than the kathode rays. This result is in complete agreement with the previously described result, that the fluorescence of the screen can be still observed at 2 metres from the vacuum tube. In general, other bodies behave like air; they are more transparent for the X-rays than for the kathode rays.

(11) A further distinction, and a noteworthy one, results from the action of a magnet. I have not succeeded in observing any deviation of the X-rays even in very strong magnetic fields.

The deviation of kathode rays by the magnet is one of their peculiar characteristics; it has been observed by Hertz and Lenard, that several kinds of kathode rays exist, which differ by their power of exciting phosphorescence, their susceptibility of absorption, and their deviation by the magnet; but a notable deviation has been observed in all cases which have yet been investigated, and I think that such deviation affords a characteristic not to be set aside lightly.

(12) As the result of many researches, it appears that the place of most brilliant phosphorescence of the walls of the discharge-tube is the chief seat whence the X-rays originate and spread in all directions; that is, the X-rays proceed from the front where the kathode rays strike the glass. If one deviates the kathode rays within the tube by means of a magnet, it is seen that the X-rays proceed from a new point; i. e., again from the end of the kathode rays.

Also for this reason the X-rays, which are not deflected by a magnet, cannot be regarded as kathode rays which have passed through the glass, for that passage cannot according to Lenard, be the cause of the different deflection of the rays. Hence I conclude that the X-rays are not identical with the kathode rays, but are produced from the kathode rays at the glass surface of the tube.

(13) The rays are generated not only in glass. I have obtained them in an apparatus closed by an aluminum plate 2 mm. thick. I purpose later to investigate the behavior of other substances.

(14) The justification of the term "rays," applied to the phenomena, lies partly in the regular shadow pictures produced by the interposition of a more or less permeable body between the source and a photographic plate or fluorescent screen.

I have observed and photographed many such shadow pictures. Thus, I have an outline of part of a door covered with lead paint; the image was produced by placing the discharge tube on one side of the door, and the sensitive plate on the other. I have also a shadow of the bones of the hand, of a wire wound upon a bobbin, of a set of weights in a box, of a compass card and needle completely enclosed in a metal case, of a piece of metal where the X-rays show the want of paper. It is faint, but unmistakeable.

For the rectilinear propagation of the rays, I have a pin-hole photograph of the discharge apparatus covered with black paper. It is faint, but unmistakeable .

(15) I have sought for interference effects of the X-rays, but possibly, in consequence of their small intensity, without result.

(16) Researches to investigate whether electrostatic forces act on the X-rays are begun but not yet concluded.

(17) If one asks, what then are these X-rays; since they are not kathode rays, one might suppose, from their power of exciting fluorescence and chemical action, them to be due to ultra-violet light. In opposition to this view a weighty set of considerations presents itself. If X-rays be indeed ultra-violet light, then that light must possess the following properties.

(a) It is not refracted in passing from air into water, carbon bisulphide, aluminum, rock-salt, glass or zinc. (b) It is incapable of regular reflection at the surfaces of the above bodies. (c) It cannot be polarized by any ordinary polarizing media. (d) The absorption by various bodies must depend chiefly on their density.

That is to say, these ultra-violet rays must behave quite differently from the visible, infra-red, and hitherto known ultra-violet rays.

These things appear so unlikely that I have sought for another hypothesis. A kind of relationship between the new rays and light rays appears to exist; at least the formation of shadows, fluorescence, and the production of chemical action point in this direction. Now it has been known for a long time, that besides the transverse vibrations which account for the phenomena of light, it is possible that longitudinal vibrations should exist in the ether, and, according to the view of some physicists, must exist. It is granted that their existence has not yet been made clear, and their properties are not experimentally demonstrated. Should not the new rays be ascribed to longitudinal waves in the ether?

I must confess that I have in the course of this research made myself more and more familiar with this thought, and venture to put the opinion forward, while I am quite conscious that the hypothesis advanced still requires a more solid foundation.

PROF. ROENTGEN'S DISCOVERY.[1]

BY A. A. C. SWINTON.

WORKING upon the line indicated in the telegrams from Vienna, recently published in daily papers, I have, with the assistance of Mr. J. C. M. Stanton, repeated many of Professor Roentgen's experiments with entire success. According to one of our first experiments, an ordinary gelatinous bromide dry photographic plate was placed in an ordinary camera back. The wooden shutter of the back was kept closed and upon it were placed miscellaneous articles, such as coins, pieces of wood, carbon, ebonite, vulcanized fiber, aluminum, etc., all being quite opaque to ordinary light. Above was supported a Crookes tube, which was excited for some minutes. On development, shadows of all the articles placed on the side were clearly visible, some being more opaque than others. Further experiments were tried with thin plates of aluminum or of black vulcanized fiber, interposed between the objects to be photographed and the sensitive surface, this thin plate being used in place of the wood of the camera back. In this manner sharper shadow pictures were obtained. While most thick metal sheets appear to be entirely opaque to the radiations, aluminum appears to be relatively transparent. Ebonite, vulcanized fiber, carbon, wood, cardboard, leather and slate are all very transparent, while, on the other hand, glass is exceedingly opaque. Thin metal foils are moderately opaque, but not altogether so.

As tending to the view that the radiations are more akin to ultra-violet than to infra-red light, it may be mentioned that a solution of alum in water is distinctly more transparent to them than a solution of iodine in bisulphide of carbon.

So far as our own experiments go, it appears that, at any rate, without very long exposures, a sufficiently active excitation of the Crookes tube is not obtained by direct connection to an ordinary Rhumkorff induction coil, even of a large size. So-called high frequency currents, however, appear to give good results, and our own experiments have been made with the tube excited by current obtained from the secondary circuit of a Telsa oil coil, through the primary of which were continuously discharged twelve half-gallon Leyden jars, charged by an alternating current of about 20,000 volts pressure, produced by a transformer with a spark-gap across its high-pressure terminals.

For obtaining shadow photographs of inanimate objects and for testing the relative transparency of different substances, the particular form of Crookes tube employed does not appear to greatly signify, though some forms are, we find, better than others. When, however, the human hand is to be photographed, and it is important to obtain sharp shadows of the bones, the particular form of tube used and its position relative to the hand and sensitive plate appear to be of great importance. So far, owing to the frequent destruction of the tubes, due to overheating of the terminals, we have not been able to ascertain exactly the best form and arrangement for this purpose, except that it appears desirable that the electrodes in the tube should consist of flat and not curved plates, and that these plates should be of small dimensions.

A living human hand was exposed for twenty minutes through an aluminum sheet .0075 in thickness, the Crookes tube, which was one of the kind containing some white phosphorescent material (probably sulphide of barium), being held

[1] Abstract from "Nature."

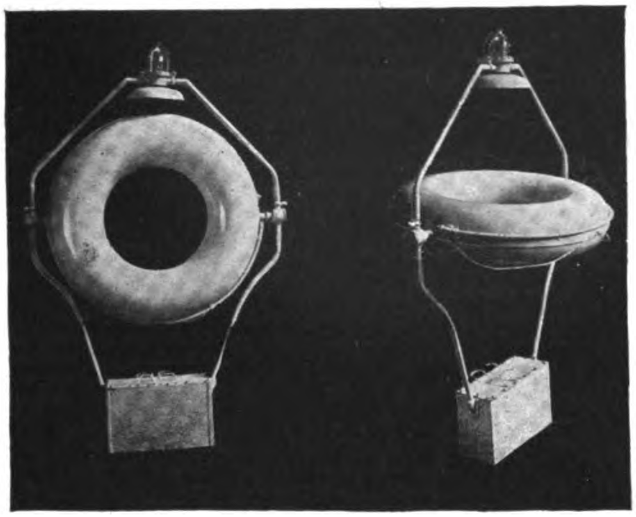
vertically upside down, with its lowest point about two inches above the center of the hand.

By substituting a thin sheet of black vulcanized fiber for the aluminum plate, we have since been able to reduce the exposure required to four minutes. Indeed, with the aluminum plate, the twenty minutes' exposure appears to have been longer than was necessary. Further, having regard to the great opacity of glass, it seems probable that where ordinary Crookes tubes are employed, a large proportion of the active radiations must be absorbed by the glass of the tube itself. If this is so, by the employment of a tube partly constructed of aluminum, as used by Lenard, the necessary length of exposure could be much reduced.

THE GUEST-BATES ELECTRIC LIFE BUOY.

OUR engraving represents a novel electric life buoy, which has been tested on board the lighthouse tender "Armeria," Commander West, United States Navy, and favorably reported upon to the Lighthouse Board.

The buoy consists of a ring mounted in a framework of metal



FIGS. 1 AND 2.—THE GUEST-BATES ELECTRIC LIFE BUOY.

tubing. The ring is normally in the plane of the frame. When the buoy is dropped into the water the ring on which the buoy floats turns so as to rest with its side on the water, and on so turning operates an automatic switch controlling the lights in the manner described below. At the lower end of the frame is the battery box, containing the cells. To keep this perfectly dry inside, a moisture absorber is placed there with the cells. The box cover is easily removable and made water-tight by a packing of rubber with wax or tar. The framework passes from the ends of the battery box upward, meeting to form an arch above the ring. On top of this arch is the lantern, a glass globe covering one or more pairs of incandescent lamps. Electrical connection between these lamps and battery cells are through the tubes of the framework on both sides. On each side of the frame is a switch box, containing the automatic switch controlling the circuit.

The ring is mounted upon trunnions journaled in the switch boxes. Where the trunnion enters the switch box it is surrounded by a water-tight stuffing box to better protect the switch. The stationary contacts of the switch are secured to the frame and box and the movable contacts are secured to the ring trunnions, but, of course, both sets of contacts are insulated from their supports. These contacts are so related to each other that the turning of the ring but a very small angle out of the plane of the frame will close the circuit and light the lamps, which will remain in circuit until the ring can be turned around nearly one complete revolution. This precaution is very important, because it insures the continuous glow of the lamps in a rough sea.

Such are the principal features of the machine. There are a few other interesting details added. One is a hand switch concentric with the lantern, added merely for precaution. It is so arranged as to be able to switch on one pair of lamps at a time, or turn off all of them. The lamps are in parallel and are used two at a time to economize battery power. If one lamp of any given pair gives out the other can supplement it until another pair of lamps can be switched on. Another addition is a bell below the lantern, automatic or other, which will be of value as a fog signal. The handle of the hand switch is surrounded by a water-tight stuffing box, like that of the automatic switch.

A very interesting problem here is that of battery power. The lamps will be from 3 to 8 volt, from ½ to 8, or more, candle power, and in every case will take about 1 ampere of current. The improvements in dry batteries of late years have been so great that the market can now furnish cells of which six in multiple series of three can glow continuously a couple of 1-candle power lamps one hour. Connected in the same way, eighteen such cells can glow these lamps three hours, and thirty-six of them can glow the same lamp six hours. More hours can be gotten by adding cells, but the latter case will be amply sufficient for most work. For lamps of large candle power for use a longer time a storage battery is at present recommended, having easy access to a dynamo to charge them up every two or three months. Accumulators are now so well made that they will lose but 20 per cent. of their charge by standing in a place kept dry as the buoy battery box will be. Hence, on a steamer which almost always has its dynamo, the care of cells is an easy matter. There is now being designed a salt-water battery of such power that it will glow a strong light for several whole nights continuously when overboard, its capacity being large, without occupying much room.

The Guest-Bates device is being exploited by the Guest-Bates Marine Life Saving Appliance Company, of this city.

ANOTHER ANALYSIS OF THE DETROIT MUNICIPAL FIGURES.

Mr. C. Livingston, well known in lighting affairs at St. Paul, Minn., where he has large interests, has written as follows to the "Detroit Free Press" on the subject of the recent municipal plant figures. It will be remembered that certain items have already been discussed, pro and con, in "The Electrical Engineer," but Mr. Livingston makes additional points in his argument:

In your issue of Friday, January 10, you give the average cost per lamp per month of the public arc lights of the City of Detroit at $7.20. I am always at a loss to know what advantage it is to an individual or a municipality to deceive him, or itself, which you certainly do and which Detroit certainly does in the statement you publish. In the detailed statement of the cost of operating the public light plant which you give, the question of depreciation of the plant, insurance, water and also taxes are all eliminated. The figure $1.34 is the interest charge per lamp per month. If I am correctly informed, the plant cost $650,000. Interest even at 4 per cent. would amount to $1.46 instead of $1.34 per lamp per month. Taking, however, your own figures of $1.34, plus $5.86 for the items you mention, gives the figure you state, $7.20 per lamp per month. I am informed that the value of the real estate is $145,000. Taking this from the total cost of the plant ($650,000) would leave $505,000 as the cost of the machinery. It is the consensus of opinion of the best electrical experts that depreciation in electrical machinery is at least 10 per cent. a year. Say, however, the value of the machinery is $400,000; 10 per cent of this is $40,000; to this add the cost of insurance, say 1½ per cent. on $545,000, which is much below the going rate of insurance on electrical machinery, and you have the total cost of these two items, $48,-175, which divided by 1,483, average of lamps in use during the months you enumerate, would give the cost per lamp per year as $32.48; dividing this again by 12 and you find the cost per lamp per month is $2.70 for these items; adding this to the $7.20 as given above, gives us $9.90 per month as the cost of each arc lamp. Multiplying this by 12 (the number of months in the year) gives us the cost per year for every arc lamp at $118.80. If the interest figure which I give above as $1.46 is correct, the cost per year would be $120.24. I am told that the assessed value of property in Detroit is about 80 per cent. of its real value, on which the city receives a tax of 2 per cent. If this be true, the assessed value of your electric lighting plant would be $520,000, 2 per cent. on which is $10,400. The loss of this tax should be added to the cost of your lights, for the reason that if the municipality did not own its own plant, some private corporation would, and the city would receive the tax above stated. There are various other items of expense which experience shows every electric light plant, whether owned by individuals or municipalities, are the natural sequences of the business, such as patent and personal damage suits. In fact, in a railroad company, of which I am a director, 5 per cent. of our gross earnings is credited to the fund to pay for personal damages each year, and the amount so credited does not equal the amount paid for personal damages, and in an electric lighting company that I was formerly connected with, in a much smaller town than Detroit, in eleven years' time the smallest amount paid for personal damage cases in the form of legal expenses and settlements, in any one year, was in excess of $6,000.

CATHODOGRAPHS WITHOUT CROOKES TUBES.

BY WILLARD E. CASE.

WHILE experimenting with the new method of photographing hidden objects by the Roentgen method, with cathode rays from the Crookes tube, the writer discovered that he could do away with the tube entirely. The experiment is somewhat as follows:

A sensitive photographic plate, in its paper case, was placed between two metallic plates, placed 6 inches apart, which were connected with the terminals of an induction coil giving a ½-inch spark, and on this paper case there was laid a piece of metal which was covered with another piece of paper. The plate was thus exposed for about fifteen minutes. On the plates being developed, it was found that a picture of the metal piece had been photographed on the plate.

Afterwards another sensitive plate, inclosed in a paper box, was placed, not between the two metal plates, but back of one of them, and left for about fifteen minutes, while the rays were passing between the two plates.

On developing the plate a picture, or, rather shadow, of one of the metal plates was found on the photographic plate, which would tend to show that the rays pass in straight lines from one plate to the other, and those going past the plate, into space, acted on the sensitive plate beyond.

If these rays can be thrown to a distance, what tremendous possibilities it may open up, as hidden objects could be photographed in absolute darkness at a distance only limited by the distance at which the rays may act. And so might shadows be thrown, by which new methods of communication could be made.

Another interesting fact noted was that on placing a vacuum tube in the vicinity of the condenser plate and the sensitive photographic plate the rays seemed to be deflected, giving an imperfect image of the edge of the plate.

LETTERS TO THE EDITOR.

THE POLICY OF CITY OWNERSHIP.

I note in this week's issue Mr. Dow's further discussion of the Detroit municipal lighting plant, together with his comments on my communication on the subject.

There is little further to be said in the matter. Inasmuch as none of the statements of fact are called into question, it would only be a waste of words to discuss what may occur in the future other than to reiterate what was stated before, viz., that it is a well-known fact that public enterprises under municipal control and management are not conducted on as economical a basis as when administered by individuals or private corporations.

Of course, rare exceptions may and do exist on both sides, which simply prove the rule. If municipal affairs were always administered by the best citizens with the sole purpose in view of producing the best results for the taxpayers, there would be no occasion for discussing this subject.

Whether Detroit will be able to break the record and prove to be a shining example in the administration of public enterprises, rather than to repeat her record, which is fair, compared with that of other cities, the future alone will tell us.

The record in Chicago, which is only for a period of seven years, is open for investigation and speaks plainly for itself, confirming all and more than has been said against municipal ownership of lighting plants.

There is no question in my mind about Mr. Dow's intentions or desire to do that which is right and to the best interests of his employers, and the fact that he is employed by a municipality will make him none the less efficient in endeavoring to do what he believes to be right in the management of the property under his charge. But that he can control the situation so as to produce his anticipated results is not to be reasonably expected by any one who has given any attention to the outcome of municipal management of property of this character.

Boston, Mass., Feb. 1. JAS. I. AYER.

CATHODE PENUMBRAS.

Is it not possible that the so-called cathodic rays, while not subject to the ordinary laws of refraction, may under proper conditions yield to analysis by diffraction? I am led to this query by noticing in Professor Wright's print of three spheres in a box, a very marked penumbra about each shadow. May not this be caused by diffraction? It would be necessary in order that this should be so that the wave front should be changed by the difference in intensity of the light passing by and through the sphere.

J. B. HENCK, JR.

Brooklyn, N. Y.

"ON HIS BASE."

Referring to our friend Jenks' opinion on lamp bases, it occurs to the writer that it would be well to patronize companies who produce lamps that do not droop, inasmuch as there are several manufacturers offering products embracing this excellent point. Furthermore a sign or display of several thousand lamps ranging from 20 to 150 feet from the ground affords quite a substantial argument against the turning process as advocated by our disciple of the pinnacle base. This turns the Philadelphia gentleman's argument in favor of the Edison base. OLIVER E. BRASTOW.

Boston, Mass.

USEFUL TO ENGINEERS AND INVESTORS.

I beg you to let me take this opportunity to congratulate you most heartily upon your issue of Jan. 8, as well as upon your paper as a whole.

Your articles from time to time descriptive of central stations and central station management are of the greatest possible value; and I believe investors in electrical enterprises generally place the highest value upon your careful and conservative analysis of the balance sheets of our various large electrical corporations. Your paper keeps well abreast of the times in regard to technical matters, and I look for each weekly issue with extreme interest. The work you have done, and are doing, deserves the gratitude of all members of our profession. R. B. OWENS, Prof. of Elec. Eng.

Dept. of Elec. Eng., University of Nebraska.

A SPECIALTY OF THE "ENGINEER."

I am glad to say to you that I prize most highly the truly pre-eminent speciality of "The Electrical Engineer" of describing and illustrating central stations. Mr. Wetzler's recent article on the New York Edison stations has most especially pleased me. HARRIS J. RYAN, Professor of Elec. Eng.

Cornell University, Ithaca, New York.

A CATHODOGRAPH SUGGESTION.

I have been much interested recently in the Röntgen method of photography, and a very strong suspicion has entered my mind that it is not light that acts on the sensitive plates, but is a heretofore unknown property of electrical vibrations of high frequency and voltage. Perhaps the same results may be accomplished by connecting the terminals of a Tesla coil to sheets of metal, placed on opposite sides of the camera and the subject to be photographed, though I do not think that the failure of this experiment would disprove the supposition. The discovery appears to depart from all known laws of light, while electrically I do not know of any law with which it disagrees. I may be wrong in my surmises, but I think that the idea deserves a thorough consideration before being thrown over. At best, it appears to be all a matter of guesswork at present. HARRY E. DEY.

New York, Feb. 4, 1896.

(This letter, it will be seen, was written before the issuance of our Feb. 5 issue, containing the account of Dr. Morton's experiments.—Eds. E. E.)

CONVENIENT AND VALUABLE.

We beg to acknowledge receipt of the cloth-filing case for the little data sheets, and thank you for the same. By the way, these little sheets have been found to contain a lot of valuable information in a convenient form.

W. W. NICHOLSON, General Superintendent.

Central New York Telephone and Telegraph Company.

Utica, N. Y., Jan. 15, 1896.

THE

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[INCORPORATED.]

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CONTENTS.

SUPPLEMENT.

ELECTRIC UNDERGROUND TRACTION FOR NEW YORK CITY.

THE New York Supreme Court Rapid Transit Commissioners who have been investigating the subject of the proposed underground road, are said to have reached the close of their labors. The reports printed in the daily papers show that they have received a large amount of testimony of the usual contradictory nature, which might well have left them with confused ideas and puzzled minds on almost all the points connected with the great scheme. Curiously enough, even the ability of electricity to handle the traffic has been made a special feature of controversial evidence, reading some of which makes one wonder whether electric motors have ever yet hauled a single passenger anywhere. It might seem that at this late day, when electric traction has not only a virtual monopoly of street railway work, but is competing with steam locomotion on cross-country roads, arguments against electricity would have little weight, and that the existence of the facts would be conceded. But that lingering prejudice has strength must be inferred from the attitude of the "Evening Post," of this city, which, although an avowed advocate of the underground road, collated recently with much care and ability all the data going to show that electricity could not be depended upon as a motive power. In short, a desire to be fair had apparently led the "Post" into the position of taking the pessimistic view on every one of the points raised—power, speed, frequency, braking, signaling, etc.; and the result was, as we happen to know, serious discouragement to many people.

At such a juncture it is fortunate that Mr. Frank J. Sprague has allowed himself to make, in an excellent interview in the same paper, a full exposition of his own views and beliefs on the subject. It is a most timely publication, if only as proving that the same facts are often capable of being regarded from diametrically opposite standpoints. But it goes much further than giving a right aspect to existing conditions, or a correct interpretation to technical data. It unfolds a broad plan for securing the desideratum so long under wearisome discussion, and, to us at least, shows that, be the method of raising the capital what it may, the system of propulsion is not an element of uncertainty, but a feature whose success should be treated as a foregone conclusion.

To those who are not familiar with Mr. Sprague's work, his brisk alertness in the defence of electricity may be remindful of the cartoon which represented Mr. Gladstone as a terrier pricking up its ears on the mere whispering of the word "Atrocities;" but the impression made by the article in the "Post" was in some ways most regrettable, and it needed prompt refutation by somebody entitled to public confidence. Mr. Sprague speaks with all the authority of long experience, fertile invention and brilliant success, and his admirable review of the case must have convinced the public that electricity is ready to run the road as soon as the road is ready to run. As for the plans underlying Mr. Sprague's statement, we may say that they have already been noted by us in a recent article and comprise single car units, but we may briefly quote him here as to details:

The control is unique. Each car is equipped not only with its own motor, but also at each end with a duplicate controlling device, operating not only the motor control, but an auto-

matic brake, and being itself automatic in action under certain emergency conditions. Such a device has been practically and fully tested under the severest conditions. When desired, two or three, or even six cars, can be indiscriminately coupled together, in any order, at any part of the line, without head-and-tail switching, and, all other controllers being for the time thrown out of action, the leading car platform is made the place of simultaneous control of all car motors and brakes, or at will any selected one of twelve places, that is, either end of any of the six cars in the train, can be made the controlling point. Simultaneous control of a number of machines of the required power has already been practically demonstrated, and I am preparing to make a demonstration of such a system in actual operation. Current will undoubtedly be supplied by continuous rail contact, using either a side or a middle rail, slightly elevated, or, preferably, a rigid overhead rail secured to insulators in the roof of the tunnel and following the middle line of all tracks and switches, the car thus running, as it were, between two electric planes of practically constant difference of potential, making a flexible overhead and running rail contact, and free to follow without difficulty any combination of tracks and switches. This is the plan I suggested for the underground railroad of London as early as 1882, and I see no reason for changing it.

By a happy coincidence, the interview with Mr. Sprague appeared the same day that the commissioners had before them Mr. David L. Barnes, the well-known railroad engineer, representing the Westinghouse-Baldwin interests, who also threw the weight of his authority on the side of electricity, speaking from the manufacturers' standpoint. He stated that an electric motor attached to six loaded cars could reach a speed of sixty miles an hour in forty-seven seconds, and within 2,700 feet of its starting point, and while going at that rate could be stopped within 1,500 feet. The cost of equipment for 20 express trains, with motor and five cars to each train, would be $330,000; 150 local trains, motor and three cars to each train, $1,720,000; conductors, $715,000; central station equipment, for express trains, $504,000; for locals, $1,380,000, a total cost of $4,649,000. With that equipment trains could be run at about three-minute headway for express trains, and from thirty to forty-five seconds for local trains. It will be noted, of course, that Mr. Barnes based his remarks on the locomotive method, rather than the "unit," but if the commission has any lingering doubts on the ability of electricity to haul either single cars or trains, it will certainly be a matter for genuine surprise.

CATHODOGRAPH METHODS.

NOT perhaps since the publication of Professor Crookes' memorable experiments on radiant matter has there been announced a scientific discovery more calculated to arouse the interest of the general public than that of Professor Roentgen. Scarcely a day has passed for the last few weeks without the record of some new experimenter at work or of the application, real or fantastic, of the "X-rays" to some purpose. Perhaps the most important advance made since the announcement by Professor Roentgen regarding this dark ray photography is that the process can be carried out without the intervention of a Crookes tube. This was proved experimentally by the work of Dr. W. J. Morton, described in our issue of last week, in which a record was obtained by placing the sensitive photographic plate between the two main conductors of a static electrical machine. A still further advance on these lines is that chronicled in this issue, and due to Mr. Willard E. Case, who has succeeded in obtaining distinct shadow effects from a comparatively small induction coil, at ordinary atmospheric pressures, and who suggests a possible method of utilizing the phenomenon in a practical way. One of the most gratifying manifestations of this new research is the interest which it has aroused among our celebrated inventors. In last week's issue Prof. Elihu Thomson gave some of his views on the subject, and this week supplements them by suggestions and sketches of apparatus for obtaining the best effects with the new method. We dare say that makers of scientific apparatus and other experimenters will not let the suggestions pass unheeded. Mr. Edison, also, has succumbed to the fascination of the X-rays and, dropping for the moment his magnetic ore separating processes, has plunged into the subject with his old-time energy and enthusiasm. Mr. Edison seems to hold views at variance with those heretofore generally accepted, as to the quality of the vacuum required to obtain the best emission of the X-rays; but as his opinion is based on the results of numerous experiments, they would appear to be entitled to full consideration. A very characteristic demonstration of the permeability to the X-rays of various substances is the reproduction of a cathodograph taken by Mr. Edison, which we print on another page. All the samples being taken under precisely similar conditions, the cathodograph gives an admirable graphical illustration of the relative value of the various materials as substances for the making of vacuum tubes to generate X-rays. It may be considered a trite remark to repeat that this new work opens up a wide field, regarded both scientifically and practically, but we are certain that even after the discovery has ceased to be the nine-days' wonder into which it has been converted by the daily press, it will occupy a prominent and lasting position in the annals of science.

MUNICIPAL ELECTRIC PLANTS.

IT would have been strange if the present New York Legislature had not seen some of the municipal lighting plant schemes that have been promoted everywhere else in the country; and we now note the introduction of a bill of this character in both the Senate and the Assembly. It provides that any city in this State may establish electric light plants for its own use and for the use of its citizens. No city shall have authority to exercise this power until granted by the Common Council by a majority vote and approved by the Mayor and ratified by the voters of the city. If refused ratification the matter shall not be resubmitted for at least two years. Cities establishing such plants are authorized to pay for the same by the issue of bonds, to be issued for not exceeding thirty years, and the bill also provides for appropriations each year to pay these bonds. The control of such plants is to be under the Common Council. The price to be charged for electricity is to be fixed at not less than cost, and must not net a profit exceeding 8 per cent. When existing electric light plants, owned by corporations, are sold to cities, such corporations shall cease to exist. A copy of the full text has not reached us, but the digest makes no mention of protection to existing investments by purchase of them at a reasonable price before the city plant is started. The authors of this bill may be well meaning, but we venture to recommend it to the notice of the new State Association, which can at once justify its existence and utility by educating public opinion against such schemes. The association has plenty of good work to do, but none better than this.

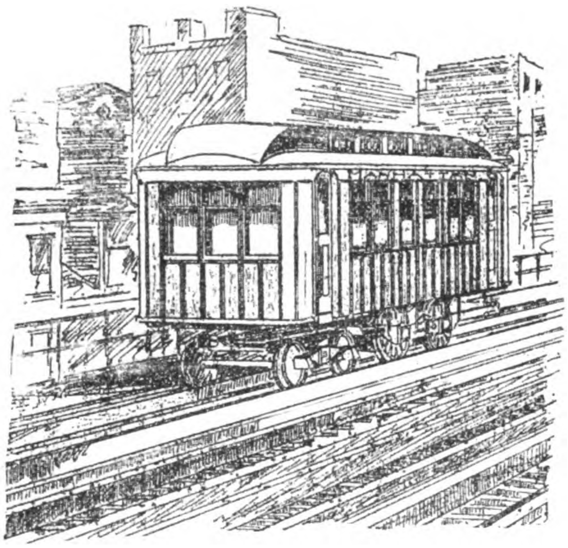
ELECTRIC TRANSPORTATION.

ELECTRICITY ON THE NEW YORK ELEVATED RAILROADS.—A COMBINATION OF THIRD RAIL AND STORAGE BATTERY TO BE TRIED.

AFTER an extended investigation the management of the New York Elevated Railway system have once more decided to experiment with a method of electric propulsion, and in this instance propose to give a trial to a system combining the third rail direct supply with the storage battery carried on the motor car.

This system, it is stated, has, among others, the following advantages: Greater speed in starting with less expenditure of energy, less vibration to the structure for the reason that the power is rotary; electric light and heat in cars; absence of smoke and steam; great economies in coal, cost of operation and maintenance of structure; absolute reliability of service, for either system may be relied upon to carry the train to its destination.

If adopted for all the lines the saving in the consumption and handling of coal, it is estimated, will amount to $900,000, equal to 3 per cent. on the capital stock, and the additional saving in repairs and maintenance of engines and in other important items will be equivalent to the interest charge incurred by the



NEW MOTOR CAR, MANHATTAN ELEVATED RAILROAD, NEW YORK

change of equipment, the total cost of which will amount to about $6,000,000.

The work of installation will be carried out by the Electric Storage Battery Company of Philadelphia, aided by the General Electric Company. An electric locomotive carrying motors on the axles and a storage battery plant in the cab of the locomotive will be used. The elevated structure will be equipped with a third rail to carry current to the trains. The storage battery on the locomotive and the motor will be connected in parallel with this third rail. Electric current will be conveyed by this third rail to the locomotive from a power station near the lines.

If adopted for all the lines, the main station will be situated outside the city limits, in order to secure the economy of cheap land and cheap fuel. In this station, machinery of large size and the highest possible efficiency will be used, which will generate alternating current at a high tension, which can be conveyed to sub-stations along the lines of the Elevated Road with very small loss in energy and cost for conductors. These sub-stations will reduce and transform the high tension alternating current into a low tension constant current with which the third rail will be fed.

The experiment will be made on the Thirty-fourth street branch line, and our illustration shows the type of motor car which will be used.

The battery locomotive will consist of the present locomotive frame, somewhat altered, with two G. E. 2,000 (500-volt) motors, mounted on the driving axles, the frame carrying a body which is similar in appearance to that of the regular cars, in which the batteries will be carried. These will consist of 248 cells, of 400 ampere-hours' capacity each, the total weight being 10 tons.

This battery is always in parallel with the third-rail connection with the power-house, and the speed of the car is controlled by the usual series-parallel combination of motors. The advantage of this system is that the batteries being in parallel with the third rail will keep the current in that conductor of a steady average value. What will be gained by this will be seen from the following data:

At present in the Elevated Railway service, the car no sooner obtains its maximum running speed than it must stop and shut down. A high speed over the line cannot be obtained except by a greater rate of acceleration in starting, and for this steam locomotives of the weight allowed on the structure cannot give the necessary drawbar pull. The average distance between stations of the Elevated Road is 1,700 feet. The average running time for this distance is 85 seconds.. The following data show the variation, maximum horsepower, maximum drawbar pull, maximum speed attained, braking distance of train from maximum speed and the horsepower hours per train-mile.

Power applied for 15 seconds: Maximum horsepower, 655; maximum drawbar pull necessary, 13,050 pounds; maximum speed, in miles per hour, 18¾; braking distance from maximum speed, 190 feet; horsepower hours per train-mile, 4¼.

Power applied for 32 seconds: Maximum horsepower, 364; maximum drawbar pull, 6,800 pounds; maximum speed, 20 miles an hour; braking distance, 215 feet; horsepower hours per mile, 5.

Power applied for 49 seconds: Maximum horsepower, 310; maximum drawbar pull, 5,170 pounds; maximum speed, 22.50; braking distance, 276 feet; horsepower hours per mile, 6.55.

Power applied for 58 seconds: Maximum horsepower, 324; maximum drawbar pull, 4,850 pounds; maximum speed, 25; braking distance, 340 feet; horsepower hours per mile, 8.1.

Power applied for 65 seconds: Maximum horsepower, 346; maximum drawbar pull, 4,775 pounds; maximum speed, 27.2; braking distance, 405 feet; horsepower hour per train mile, 9.65.

The average speed for all of these is 13.6 miles an hour, not including stops at stations.

The figures above show that if the power is applied to the train for a shorter length of time, a greater drawbar pull and greater maximum horsepower are necessary; but that the maximum speed to be attained is less, as the train runs for a considerable length of time at full speed without acceleration before commencing to slow down; that the braking distance in feet is less from maximum speed, thus giving a greater safety to the service; and that the energy to propel the train in this distance becomes considerably less by getting up the speed quickly. This is due to the fact that a

much less part of the momentum of the train is wasted at the brakeshoes in shutting down.

It will be seen that in order to get the most efficient service, it is necessary that a great deal of power should be applied for a short length of time. This in any sort of a straight trolley system would mean a very greatly varying load for the conductors and generating machinery, and far in excess of the average power would have to be installed. The storage battery on each train keeps the power supplied to the train of the average value, and allows of the installation of generating machinery and line conductors for only the average demand of the system.

The batteries on the locomotive have the advantage over batteries placed in the main station, or in substations, in that the regulation or voltage at the motors themselves is very much better. Any congestion of traffic means a distribution of battery in the same way; stationary batteries would each have to have capacity for maximum number of trains on their section.

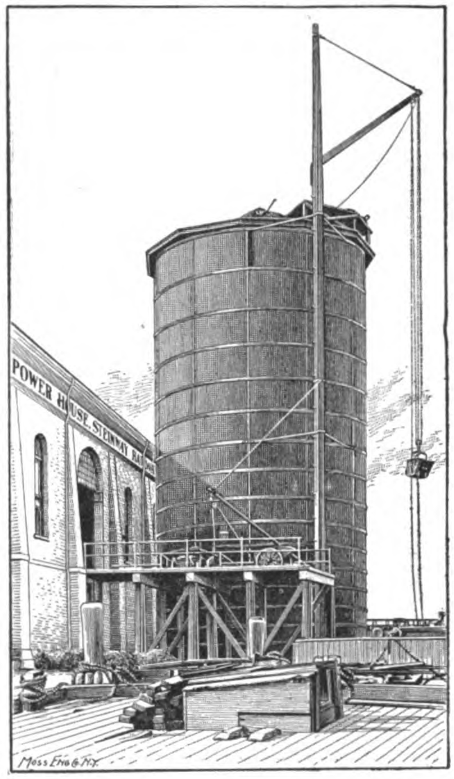
The batteries on the different locomotives are all connected in parallel by the third rail, so that they all work in unison for any variation of load in their immediate vicinity, and hence the amount of battery needed is less than if installed in sub-stations along the line. The weight of battery necessary on each locomotive is no more than is required for traction purposes, and the weight of the battery locomotive is calculated not to exceed that of the present steam locomotive.

The running of the third rail conductor will be made very simple, in that it need only be installed on a straight track. On curves, crossings, and in and out of car barns and locomotive house, the batteries do the work alone. The batteries have a capacity sufficient to run the train for about 25 miles without aid from the third rail conductor. It is understood that the batteries are never taken from the locomotive, as the average current maintained by the line charges the battery at times of light load equalling in amount what is discharged at times of heavy load.

In regular service the batteries will never be called upon to discharge more than 2 to 3 per cent. of their capacity before they are charged again, making the service perfectly easy on the battery; a very long life is anticipated for them in consequence. The reduction in the amount of coal burned over the present system is estimated at 60 per cent., and a very large saving in the present cost of handling coal.,

COAL HANDLING IN THE STEINWAY TROLLEY POWER HOUSE, ASTORIA, L. I.

A VERY important element in the designing and building of power plants is the question of the proper storing of coal. No power plant should be designed without providing for the storage room for from 500 tons to 1,000 tons of coal, and in larger plants this capacity should be very much increased. The danger of a strike in the coal regions, or delay in transportation incident to strikes, weather, floods, etc., are so many and great that no power plant should take these risks, but should provide storage for sufficient coal on hand to provide against a contingency of this kind. The difficulties in designing a proper bin or pocket for storing this coal are many and great, owing to the large floor space required. Our attention has been called to a pocket lately designed by the Berlin Iron Bridge Co., of East Berlin, Conn., for the power house of the Steinway Electric Railroad Co., at Astoria, which has attracted much attention. This design is unique and possesses many points of merit, owing to the large amount of storage capacity in proportion to the exceedingly limited amount of floor space occupied. The general appearance is shown in the accompanying illustration, which is taken from a photograph of the completed pocket, in operation. Especial attention is called to the cylindrical form of construction. This particular pocket is 28 feet in diameter, 54 feet in height, and has a capacity of 1,000 tons of coal. The coal is unloaded from the barge or carts, at the side of the pocket in the ordinary way, and hoisted by means of a bucket to the top of the pocket, an ordinary hoisting engine being all that is necessary. There is an



COAL POCKET, STEINWAY, L. I., ELECTRIC RAILWAY.

opening in the side of the pocket, near the base, for removing the coal in the ordinary way, so that it can be carried into the boiler room by means of an endless chain, with buckets, or by hand, or by carts, or in whatever way may be desired. The advantage of this pocket does not lie in its presenting any additional facilities for handling coal, but more in its being an economical method of storing coal, and as such, it is claimed to have unusual capacity in proportion to the floor surface. The patents on this construction are owned and controlled by the Berlin Iron Bridge Co., of East Berlin, Conn.

A 103 MILE TROLLEY LINE FOR INDIANA.

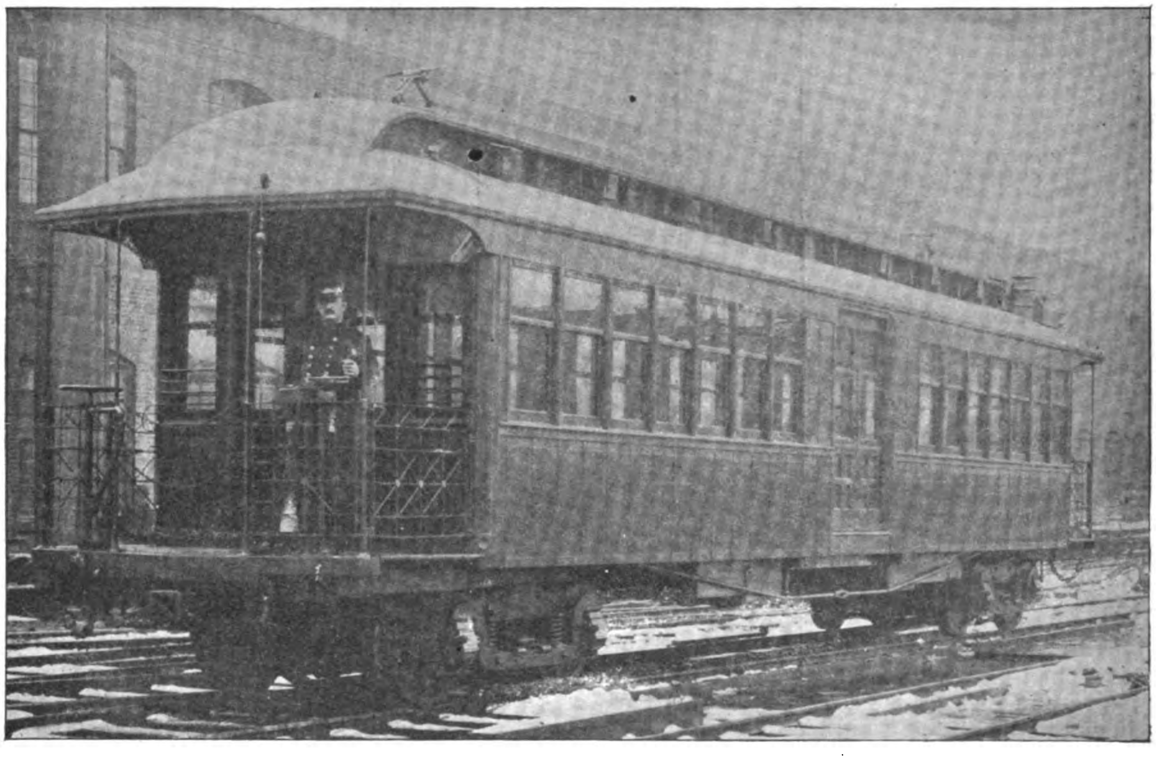
An electric line 103 miles in length is projected through northern Indiana, starting at Celina, Ohio. It is planned to build northwestwardly through Geneva, Montpelier, Warren, Lincolnville, Wabash, Roann, to Rochester. It is the intention of the builders a wealthy syndicate, to handle both freight and passengers at extremely low rates, and the line will be laid with 70-pound steel and finely equipped. Charles Everett, of Fort Wayne, representing the syndicate, last night met a large number of Wabash business men and said that a subsidy of $70,000 would be asked from this county. The capitalists will put a million and a half in the property, and it is hoped to have the road in operation in one year.

ELECTRIC MOTORS ON THE BROOKLYN BRIDGE.

THE first official test of electricity as applied to the switching of the cars on the Brooklyn Bridge was made Feb. 8. The motor car, equipped by the General Electric Company, was coupled to three of the ordinary passenger cars and the complete train of four cars was switched by the motors from the incoming to the outgoing platforms and thence to the cable sheaves several times. The car was then taken over the complete bridge circuit twice. Complete satisfaction was expressed by the president and by Chief Engineer C. C. Martin at the manner in which the work was performed.

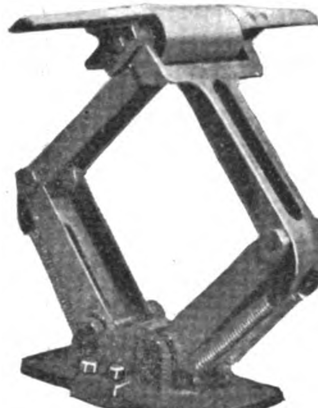
If the general plan adopted at first proves economical as well as satisfactory, a certain number of cars will be equipped with four motors, one on each axle. Each of these motor cars will remain with its own train at all times, switching it from the incoming to the outgoing tracks and pulling or pushing it over the tilting sheaves, when the grips will take up the cable and the motors cease work. Should the grips slip while the train is mounting the 3.78 per cent grade, the motors can come again into requisition and assist the trains over the summit. Moreover, during the early morning hours, when traffic has become light and the cable is no longer running the trains can be operated entirely by motor cars, as they now are by the locomotives. The eventual outcome will probably be the exclusive operation of the bridge railroad by these motor cars. Meanwhile, they will switch the trains, and as each train is equipped with its own switching power, the motor car, all the interference which the steam locomotives have hitherto placed in the way of the incoming and outgoing trains will be done away with and the complexity of the switching be greatly reduced. At present the time consumed in switching a train is twenty seconds, and in that time a large number of people gather on the platforms. With the new motor and the new principle of operation it is expected that passengers will at all times have cars waiting for them. Besides the gain in time in the switching operation, all the inconveniences of the locomotives—the noise, smoke, steam and gases—will be eliminated, and this in itself will be no small gain.

Car No. 76, one of the regular passenger cars of the Brooklyn bridge, has been selected to receive the first electrical equipment. All the apparatus, with the exception of the controlling handles and circuit-breakers, is placed out of sight beneath the floor of the car. The ordinary light Pullman trucks on which it has hitherto run and the cable grip mechanism have been removed. Heavier trucks were necessary to carry the motors. These were supplied by the McGuire Company, of Chicago, and combine the best features of the passenger and locomotive truck.



Electric Motor Car On The Brooklyn Bridge.

The general character of the motor equipment is similar to that in use on the Chicago Elevated and Nantasket Beach roads, above mentioned. The motors are of the G. E. 1200 type, exerting a horizontal effort of 1200 pounds when mounted on a 33-inch wheel. Four of these motors are employed, one to each axle, or two to each truck. They are completely incased and are water and dust tight. The armatures are of the well-known iron-clad type, the windings being sunk into slots in the armature core. The Eickemeyer winding is used



Trolley Arm On Brooklyn Bridge Motor Car.

on the armature; by this method the crossing of two wires of large difference of potential is avoided.

The ratio of reduction between the armature shaft pinion and the wheel gear is 3.5 to 1. Each motor weighs about 3,000 pounds. With this equipment and the regular train a speed of about fifteen miles an hour may be obtained. Each motor is suspended on the truck from two trunnions in the upper field set in two bars, the outer ends of the bar resting on elliptical springs. The axle is thus relieved of nearly all the weight of the motor. At the base of each motor, facing the ends of the car is a small roller which depresses the cable and allows it to pass the motor without injury, while a long iron bar runs beneath the truck and depresses the tilting sheaves, preventing them from striking the motor.

The operation of the motors is controlled by series parallel controllers of the L 4 type, which have given such general satisfaction on the Chicago roads.

The resistances as well as the magnetic cut-outs are also placed beneath the car floor. Beneath each hood of the car is an automatic circuit breaker, placed within easy reach of the motorman. The operation of this device is instantaneous and is an effectual safeguard against any accident to the motor. These circuit breakers take the place of the main circuit hood switches, but are wired in multiple with each other instead of in series. To guard against any possibility of one being closed while the motorman is at the other end of the car and desires to open his main circuit, only one handle is provided. The handle cannot be taken off without opening the circuit breaker, and when removed the circuit is locked open. As the motorman must take the controller and circuit breaker handles with him when changing ends, all danger of complication is avoided.

The car is equipped with twelve electric heaters, manufactured by the Consolidated Car Heating Company, of Albany, N. Y.

The collector which will take the current from the overhead wire is a diamond-shaped frame of metal set longitudinally upon the roof of the car and carrying at right angles a bar in the center of which is a roller. The arms are wide enough to preclude any possibility of missing contact. The diamond frame is depressable and expansible on the principle of the pantograph, allowing a play up and down to conform to the varying heights of the overhead wire. With this collector the trouble of reversing is entirely done away with.

The power to run the car will be taken from the overhead wire already in position, supplying current to the electric lights in the cars. The extra current, however, will be supplied from the Fulton street feeder of the Kent avenue station of the Brooklyn City Railway, the return wire being connected to the rails of the surface road.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS, ISSUED FEB. 4, 1896.

Accumulators:—

SECONDARY BATTERY. A. E. W. Boucher, Prilly, Switzerland 553,831. Filed Aug. 13, 1895.
The positive plate is gold or platinum.

ELECTRIC BATTERY. D. S. Williams and H. M. Hamrick, Philadelphia, Pa., 554,043. Filed May 15, 1895.
The combination with zinc electrode, of an electrode composed of a series of superposed perforated blocks of active material, plates of lead, similarly perforated, and interposed between the various blocks.

Alarms and Signals:

SUCCESSIVE NON-INTERFERENCE SIGNAL BOX. F. W. Cole, Newton, Mass., 553,838. Filed April 21, 1890.

NON-INTERFERENCE SIGNAL BOX. F. W. Cole, Newton, Mass., 553,839. Filed March 7, 1891.

SUCCESSIVE NON-INTERFERENCE SIGNAL BOX. F. W. Cole, Newton, Mass., 553,840. Filed May 3, 1890.

NON-INTERFERING SIGNAL APPARATUS. J. J. Ruddick, Richmond, Ind., 553,873. Filed June 28, 1890.
Details of construction.

ELECTRICAL WHISTLE CONTROLLING DEVICE. A. E. Colgate, New York, 553,900. Filed Nov. 24, 1890.

PRESSURE ALARM FOR GAS SUPPLY PIPES TO FURNACES. F. S. Baker, Chicago, Ill., 554,016. Filed July 22, 1895.

ELECTRICAL CIRCUIT CLOSER. L. B. Miller, Elizabeth, N. J., 554,074. Filed Aug. 3, 1895.
Details of a burglar alarm window spring.

APPARATUS FOR RAILWAY SIGNALING AND SWITCHING. J. D. Taylor, Chillicothe, Ohio, 554,097. Filed Oct. 21, 1894.
An improvement upon Letters Patent No. 516,903.

Batteries.

ELECTRIC BATTERY. C. J. Hirlimann, Fort Lee, N. J., 554,124. Filed Oct. 25, 1895.
The object is to provide a battery in which there is a large surface of the carbon element in a single cell.

Conductors, Conduits and Insulators:—

INSULATING JOINT. W. O. Duntley, St. Loius, Mo., 553,844. Filed March 25, 1895.

ELECTRIC CONDUCTOR AND CONTACT DEVICE THEREFOR. W. P. Allen, Chicago, Ill., 554,103. Filed July 15, 1895.
A shallow conduit arrangement with the conductor enclosed in a flexible metallic casing.

Distribution:—

ELECTRIC TRANSFORMER. W. K. Freeman, Ft. Wayne, Ind., 553,847. Filed July 5, 1895.
Relates to a novel form of transformer plate.

Dynamos and Motors:

COMMUTATOR FOR MAGNETO-ELECTRIC MACHINES. J. C. Henry, Westfield, N. J., 554,063. Filed Dec. 16, 1891.
A commutator for a magneto-electric machine having the radial arms of its alternate segments surrounded with insulation, and insulation applied to the alternate segments only.

Lamps and Appurtenances:—

ELECTRIC ARC LIGHTING. G. R. Lean, Cleveland, O., 553,919. Filed Sept. 26, 1895.
Similar to patent below.

ELECTRIC ARC LIGHTING SYSTEM. G. R. Lean, Cleveland, O., 553,920. Filed Sept. 27, 1895.
Similar to patent below.

ELECTRIC ARC LIGHTING. G. R. Lean, Cleveland, O., 553,921. Filed Sept. 27, 1895.
It is the object of this invention to provide means whereby two or more lamps, not in themselves adapted to burn in series, can be successfully operated in multiple arc series on high voltage constant potential circuits.

ELECTRICAL IGNITING DEVICE. W. Kaiser, Vienna, Austria-Hungary, 553,960. Filed Sept. 6, 1895.
A sparking igniting arrangement.

ELECTRIC CARRIAGE LAMP. P. H. Quinn, New York, 554,089. Filed Dec. 3, 1895.

Miscellaneous:—

APPARATUS FOR ELECTRIC WELDING. H. Lemp, Lynn, Mass., 553,923. Filed June 17, 1891.
The invention consists in applying to the metal heating electric currents of different frequency during the manipulation.

MECHANICAL AND ELECTRICAL DEVELOPMENT AND STORAGE OF WIND POWER. W. L. Negbaur, Brookline and J. J. Feely, Walpole, Mass., 554,138. Filed Oct. 9, 1895.
The improved device for the utilization of wind power herein described, consisting of a wind motor and a driving shaft operated thereby, a driven shaft provided with a device for storing energy substantially as described, and an intermissive clutch connection between the two shafts.

Railways and Appliances:

SPRING SUPPORTING EAR FOR TROLLEY WIRES. C. A. Lieb, New York, 553,858. Filed June 23, 1894.
As a new article of manufacture, a trolley-ear comprising a bolt portion adapted to secure the ear of the insulator, a body part, a sleeve adapted to secure the trolley wire in place and a slot in the body part between the sleeve and the bolt portion.

ELECTRIC TROLLEY. N. Muslar, West Boylston, Mass., 553,927. Filed April 9, 1894.
Details relating to trolley wheel construction.

ELECTRIC RAILWAY. F. C. Esmond, Brooklyn, N. Y., 553,978. Dec. 13, 1894.
Sections of the working circuit are switched in automatically by the car.

ELECTRIC RAILWAY. F. C. Esmond, Brooklyn, N. Y., 553,979. Filed April 19, 1893.
Similar to patent below.

ELECTRIC RAILWAY. F. C. Esmond, Brooklyn, N. Y., and H. F. Gray, Passaic, N. J., 553,980. Filed May 4, 1893.
Relates to a surface circuit closing device.

CIRCUIT CONTROLLING DEVICE FOR ELECTRIC RAILWAY SYSTEMS. F. C. Esmond, Brooklyn. N. Y., 553, 981. Filed July 1, 1893.
Relates to construction of surface contact switches.

UNDERGROUND SYSTEM FOR ELECTRIC RAILWAYS. W. P. Allen, Chicago, Ill., 554,102. Filed June 22, 1895.
Consists essentially of an inner metallic conductor, an outer metallic sheath normally disconnected from said conductor, and insulating supports at each end of said sheath, and an electrical connection through said sheath to said inner conductor.

UNDERGROUND SYSTEM FOR ELECTRIC RAILWAYS. W. P. Allen, Chicago, Ill., and A. S. Krotz, Springfield, O., 554,104. Filed Aug. 23, 1895.
The working conductor is placed in a flexible metallic casing.

Regulation:—

AUTOMATIC CURRENT REGULATOR. S. C. C. Currie, New York, 553,901. Filed Feb. 20, 1895'.
The combination with a circuit embracing a secondary battery, of a resistance device for controlling the amount of current passing through the circuit, and means comprising an expansion-rod for varying the resistance offered to the current.

REGULATING SOCKET FOR INCANDESCENT LAMPS. A. B. Hendricks, St. Mary's, Ill., 553,911. Filed June 19, 1895.
A revolving rheostat enclosed in the socket.

Switches, Cut-Outs and Etc:

ELECTRIC LIGHT SWITCH. H. W. Lawrence, Denver, Col., 553,857. Filed April 1, 1895.
A three way switch, by means of which one or more lights in a circuit may be lighted from one switch and extinguished from another located at a distant point.

FUSE BOX. J. S. Strouse, Baltimore, Md., 554,042. Filed Oct. 5, 1895.
In a fuse box having two fusible wires in electric circuits, a clamp for each wire combined with a single spring to place of tension on both clamps.

AUTOMATIC SWITCH. J. F. McElroy, Albany, N. Y., 554,080. Filed Jan. 2, 1892.
Intended for use in same inventor's train lighting system by battery charged from dynamo driven from the car axle.

FUSE HOLDER AND LIGHTNING ARRESTER. H. A. Lewis, Norristown, Pa., 554,130. Filed Jan. 17, 1895.
A binding post provided with a slot and a spring clamp having one member stationery relatively to the post, and a movable spring member extending into the slot of the post.

ELECTRIC SNAP-SWITCH. G. W. Hart, Hartford, Conn., 554,221. Filed Sept. 7, 1894.
Details of construction.

Telegraphs:

TELEGRAPHY. P. B. Delany, South Orange, N. J., 553,957. Filed July 25, 1891.
Comprehends the depletion or diminishing of each impulse of current entering the line at the transmitting station after a period of uniform duration of all impulses during which the full strength of the current has passed into the line sufficiently to actuate the receiving instrument.

TELEGRAPH KEY. W. Deats, Amawalk, N. Y., 554,112. Filed June 16, 1894.
In combination, a transmitting key lever, a rotary operating knob thereon, a circuit switch having one contact mounted upon the knob or knob spindle, and the other contact mounted on said lever.

Telephones:—

TELEPHONES. A. Dinsmore, Chicago, Ill., 553,843. Filed March 3, 1895.
Means for agitating the carbon when giving the call signal, so as to prevent packing.

REGISTERING APPARATUS FOR TELEPHONES. F. Quatram, Pankow, Germany, 553,964. Filed July 26, 1895.

ADJUSTING APPARATUS FOR TELEPHONE SIGNAL BELLS. C. F. Dunderdale, Chicago, Ill., 553,977. Filed June 27, 1895.

TELEPHONE APPARATUS. C. J. Schwarze, Adrian, Mich., 554,036. Filed Sept. 17, 1895.
The transmitting, receiving and signaling devices are all organically combined in a single instrument.

TELEPHONE SYSTEM. W. A. Houts, Parker, So. Dakota, 554,125. Filed Dec. 24, 1894.
A call box for automatic exchange telephone systems.

TELEPHONY. C. A. Randall, London, Eng., 554,141. Fied Dec. 31, 1894.
A granulated carbon transmitter, designed to avoid sparking.

MISCELLANEOUS.

RECENT IMPROVEMENTS IN AMERICA AND EUROPE IN THE STORAGE OF ELECTRICITY.[1]

BY HERBERT LLOYD.

DURING the ten or fifteen years that cover the period during which storage batteries have been more or less in commercial use, the electricians of this country have been divided into two distinct classes; and two only—those unalterably opposed to their use, and the other class firm believers, and, one might say, enthusiasts.

In Europe one gets the impression from an acquaintance with electrical engineers—in England, France and Germany, at any rate—that accumulators are considered an essential feature in almost all electrical work. Some engineers are greater advocates than others of the system, but all are apparently believers. When it is borne in mind that the discovery of secondary currents was made in 1801, and even a lead accumulator was made in 1803, it seems strange that it has only been within the last five or six years that a lead accumulator has been proved to be a commercial piece of apparatus.

A really practical storage battery was, of course, made by Planté in 1860, and another step was made in 1881, when Faure and Brush developed the battery plate made by the application of already formed active material. In about 1890 the Chloride plate was developed, differing both from the Brush-Faure and Planté. This plate depends for its usefulness on the peculiar and beautiful crystalline structure of the cast material. Although the present state of the art shows more than one excellent form of positive plate, there has nothing yet been produced comparable with a Chloride negative plate. Its capacity for weight and ability to withstand both the use and abuse which a battery, to be successful, must withstand, is almost phenomenal. In England and France the companies doing by far the greater portion of the business use no negative but a Chloride negative, and in those countries there are no fundamental battery patents in existence to-day.

In England one is impressed not perhaps with the magnitude of the battery installations, but by their number. Private house plants run by gas or gasoline engines are simply abundant. Central station batteries are being installed about as fast as central stations are built, which in England is comparatively slow. In Manchester, London and Belfast, Ireland, very large central station batteries have been installed within the past year.

Electric traction, of course, in England, and on the continent, is carried out on a very small scale, either trolley or battery traction. In Birmingham, England, a storage battery road has been in operation for some six or seven years, and has been the experimental ground for almost all makers of battery, and the service rendered was, of course ,not the most satisfactory. A little over a year ago the Chloride Syndicate got a contract for the equipment of all the cars of this line with their battery, and with the experience of their allied company in France at their back, they have been entirely successful, giving service satisfactory to the railroad company, and doing the business at a profit to themselves.

In France, the Madeleine and St. Denis Road has now been in operation over three years, running some thirty 22-foot cars, double decked, seating between 50 and 60 people. These cars have run up to this time between two and three million car miles, and the company have every prospect of gradually replacing the horsecars in Paris, in the face of the most terrific competition with steam motors, compressed air motors, gas motors, and I do not know how many more. On this road some very good results have been obtained in what they call "recuperation." A very careful test, covering 100 trips, about 11 miles each, gives the following results, according to figures given by M. Sarcia:

The car while descending a 10% grade could recover 57% of the energy expended in ascending it; on a 4% grade a return of 42% is effected, and on a 2% grade 23%. On a 1% grade the recuperation is zero, with a traction coefficient equivalent to 22 pounds per ton. If the traction coefficient could be reduced to 11 pounds per ton, there would be recovered, in utilizable form, according to their experience, 63% of the energy expended in ascending a 10% grade, and with that low coefficient of traction 23% could be recovered down a 1% grade. If the traction coefficient was zero on the level, the car having no dead resistance, either electrical or mechanical, there would be recoverable on descending a 2% grade 70% of useful energy, the efficiency of the battery being in this case 70%. An electric mountain railroad recently built on the Isle of Man, on which the grade is almost a uniform 12%, is equipped with a trolley system having a battery in the power house. On this road the car descending the grade delivers back to the battery over the line about 33% of the energy which it consumes in ascending, so that it is beyond question that these applications should be taken advantage of wherever it is possible, the economy being so apparent.

The cars that have been in operation on the Paris roads for three years are of the old type, with the batteries placed under the seats, but new cars are being equipped with one box of batteries suspended under the car, thus eliminating the many disagreeable features incident to locating the batteries under the seats. The practice heretofore has been to run 33 miles on one charge with a battery weighing about three tons. With the newer cars the battery weighs about one and one-half tons and runs one 11-mile trip on a charge, although under good conditions it would be capable of two such trips. In the new cars no mechanical brake is used at all, the braking being accomplished by the charging of the battery, although for the final stop the motor armatures are short-circuited. The motors are shunt wound, always used in multiple, and in starting, resistance is inserted in the armature circuits, which is gradually removed to increase the speed until it is all out. To attain full speed, the field is weakened by inserting resistance.

The matter of charging the batteries on this road has received very careful attention, and has been modified at various times. Originally, when the road was started, the battery was charged at a constant potential, 108 cells being thrown on to a 260-volt bus. Under these conditions the charging current commenced about 150 amperes, but gradually decreased, so that at the end of charge it has reached about 10 amperes. They now use two busses. The battery is thrown on to a bus equivalent to 2.4 volts per cell, where it is left for three hours, or until the current has fallen from 90 to about 30 amperes. At the end of the third hour the battery is thrown on a higher bus, equivalent to 2.55 volts per cell, on which the charge is completed in from one to two hours, or more, thus avoiding the use of resistance.

The most interesting feature in connection with the operation of this road is the method of re-pasting the positive plates. The positive support plate is grooved and made of an alloy, upon which there is very little electrolytic action, and by a special process the peroxide which has been deposited on the bottom of the jars in a worn-out cell is re-pasted into these grooves. Two men are employed re-pasting and are able to keep some thirty cars in continuous service, so that the cost of this portion of the operation is wonderfully small. I saw a number of these grids which had run between 25,000 and 50,000 miles, showing no evidence whatever of depreciation. The casting of these grids is carried on by a special process, by which the alloy is cast under very heavy air pressure, which method is protected by an original American patent, the French patents of which have been assigned to the French Chloride Company.

The Sector Clichy, a five-wire station at Paris, has two very large batteries installed last fall, one-half being manufactured by the Chloride Company, the other half by the Tudor Company. This battery, which is now complete, is probably one of the largest in the world.

In Germany the Tudor Company, with works at Hagen, have during the past eight years installed over 5,000 plants.

A most interesting application of storage battery has just been made by them on the street railroad of Hanover, where the cars are propelled by storage batteries within the city limits, and run by the trolley outside, the battery being charged without removal while the cars are running through the outskirts. Forty-four cars have been installed on this plan. Battery cars are also running in Berlin, Hagen and other German cities, and also in Vienna. Up to the past year the German Tudor Company has devoted its attention almost entirely to lighting work, but in Germany and France there is a feeling that the time is ripe for the development of storage battery traction, and within the next year a great deal will be accomplished in this line.

It is well known that in this country patent litigation has long interfered with the development of the storage battery business. Something over a year ago one strong company acquired all the patent rights of the contending companies, thus removing all question on the score of patents. This company being also allied with the three strongest European companies is able to take advantage of every improvement that is made either here or abroad, and can therefore produce the best battery obtainable.

[1] Read before the New York Electrical Society, Jan. 29, 1896.

Some months ago the New York & Harlem River R. R. Company, of New York, decided to place two storage battery cars on its Madison avenue line, to be operated through the Winter, in order to determine whether or not the system has been brought to a stage of advancement which would warrant the equipment of the entire road.

In the cars run from Eighty-fifth street to One Hundred and Thirty-fifth street the batteries are suspended between the axles, on the car truck, entirely independent of the car body. In fact, so independent are the trucks that thew have been run alone, without any car body on them at all. The cars have standard Stephenson bodies 10 feet long and standard Peckham trucks.

Sixty cells of nine-plate traction type Chloride accumulators, capacity 400 ampere hours, are placed in a tray about 4½ feet square and connected up solidly by lead burning, in two series, of thirty cells each. This tray is placed on a small transfer truck, running on a narrow-gauge track in a pit 8 feet below the level of the street car tracks. An electric elevator is utilized to hoist the tray full of batteries, together with transfer truck, up between the street car rails into position on the street car truck, where the tray is automatically locked and the elevator, with transfer car, withdrawn. Large contact shoes on the car, kept in place by steel springs, engage with contact plates on the trays, as batteries are raised, so that the connections are made automatically.

Each car is equipped with two G. E. 800 motors, supported outside of the axles, and two "K" controllers. A cable system will be applied to the shifting of the transfer cars in the battery pit.

The special advantages of this particular method of battery application include the features before mentioned, of low steps for cars and the standard height and width of seats; an entire independence of car body permitting of a change, as, for instance, from open to closed car bodies, and vice versa; together with an entire absence in the car of odor from the battery electrolyte; a compact, easily handled tray of batteries; utilization of space below and above the street car floor, without occupying one square foot of the car shed proper.

In the past batteries were made of a practically uniform type of small size, capacity being obtained by putting many series of cells in multiple. Now large units in batteries have come into use, just as large generating units have, an example of this being the battery installed in the Boston Edison Company's station, where each cell weighs about three tons, capacity 8,000 A. H., or 16,000 A. H. at 140 volts, with a maximum output of 8,000 amperes.

The size of cell should be increased almost indefinitely. Batteries are now constructed specially to suit the work for which they are intended. Until recently in isolated plants, such as private houses, 150 ampere-hour cells in glass jars were generally used, as many as eight of such series being installed in one house. A private house plant has been recently installed in this city, with one series of cells of 2,500 ampere-hours each, and in the last three months half a dozen similar plants have been installed, varying in size from 1,000 ampere-hours up.

Within the last year the question of electric train lighting has come up with considerable force, and cars are now running between New York and Chicago lighted by storage batteries alone, without any systems for operating dynamos and engines on the train. Train lighting in this country is a different matter from train lighting in Europe. In Europe a few 8-candle power lamps to the car are considered sufficient. The cars just referred to as running between New York and Chicago have 44 16-candle power lamps. A train consisting of five or six such cars requires a lighting plant of quite serious proportions.

Experiments are being made with more or less success with small dynamos driven from the axle of the car; a moderate-sized storage battery is used to maintain the lights when the speed of the train falls below some 20 miles an hour. A car so lighted is now running satisfactorily between New York and Washington.

Perhaps the application of storage batteries which will arouse greatest interest is that of stationary batteries applied to equalizing the load on trolley lines. Two or three plants of this character have been installed within the past year. In a road of considerable length, the application of a storage battery would save in feeder copper a great deal more than its own first cost, and the contingent advantages to be derived from the operating of the generating plant at a practically constant load are too well known to require reiteration.

The application of batteries to electric elevator installations shows as great or even greater advantages. As Mr. Sprague stated in his paper before the last meeting of the American Institute of Electrical Engineers, to operate six elevators without a battery would require a 120-kilowatt generating plant, while the average load would be but 35 to 40 per cent. of this. With a properly constructed battery, he states that the direct plant could be reduced to 60 kilowatts, or even to 50. A battery was installed last Fall in connection with the elevator plant in the new court house at Minneapolis, and the curves shown prove the effect. A similar plant is just being installed in the Chicago Board of Trade Building for the same purpose.

In this class of work, it is necessary that the battery should be capable of discharging at rates which would completely exhaust it in from half an hour to an hour. These discharges, of course, are not long continued, and the batteries as now constructed are not injured by this treatment. Up to two or three years ago a 10-hour rate of discharge was considered a maximum rate. Recent improvements in the manufacture of storage batteries have been entirely along the line of producing a battery which is capable of discharging in from one to three hours, although the cost has not materially decreased, if capacity alone is considered; but when discharge rate is considered, the cost has been greatly reduced, since a battery which can be discharged at five times its normal rate will replace one five times its size of the old type.

One feature of the battery business which has received a good deal of attention recently is the specific gravity of the electrolyte. The curves shown are very interesting, as they show how the capacity of a cell varies with the density of the electrolyte; the plates being respectively ¼ inch thick and 4-10 inch thick. The thicker plate has a maximum capacity when the density of the acid is about 1.275; the ¼-inch plate has a maximum capacity when the electrolyte is about 1.240. It is very noticeable how rapidly the capacity falls off on either side the maximum point. These curves are taken from two Chloride cells, the volume of the electrolyte being sufficient to prevent any great change in specific gravity. The mean volts on discharge shown in the upper curves rise almost regularly as the acid density rises.

The rate of discharge being the same per pound of active material, the discharge rate per superficial area is therefore approximately 40% greater with the thick plate than with the thin.

The battery just being installed in the new Edison Station at Twelfth street, New York, consists of 150 4,000 ampere-hour cells. The positive plates of this battery somewhat resemble the "Tudor" type, the negatives are the "Chloride" type. They are installed 75 cells on each side of the three-wire system; the 25 end cells on each side are used as regulating cells, being connected by copper bar to four regulating switches, two on each side, so that the battery can be discharged at different potentials. The battery has a capacity at 10 hour rate of 4,000 ampere-hours on each side, at a 3-hour rate of 3,000 ampere hours on each side, and at one hour rate of 2,000 ampere hours on each side.

The erection of the battery in two tiers, the upper tier of iron frame work, is perhaps new in this country. The insulation of the cells is effected by a special type of oil insulator, which makes this method of erection quite safe. The battery is installed in a room approximately 20 feet by 40 feet, which is, I think, the smallest space in which a battery of equal capacity has yet been placed.

Another Edison Station recently equipped is in Lawrence, Mass., where a smaller battery, with capacity of about 1,500 ampere hours is in use; this battery is discharged completely in two hours between four and six in the afternoon, during the peak of the load.

The Motocycle contest in Chicago has attracted a good deal of attention to the question of electric road wagons. The carriage which secured the gold medal, first prize, was built by Caffrey, of Philadelphia, and weighed complete 1,650 pounds, including a battery weighing 664 pounds. The battery consisted of 44 50-ampere hour Chloride cells; the wagon was equipped with two 1½ h. p. Lundell motors, with series parallel controller.

This carriage is capable of running from 25 to 30 miles on one charge at a speed of 10 miles an hour; it could attain a maximum speed of about 20 miles an hour for one hour, carrying four people. The two front wheels of the carriage are driving wheels and it is steered by the rear wheels. On the first speed with an average discharge of 5.6 amperes or two-thirds of an electrical h. p., a speed of 4.6 miles was attained, and at this speed the carriage would travel 46 miles on one charge. On the second speed, running at 10 miles an hour, it required 13.2 amperes or 1 56-100 h. p., covering by this speed about 30 miles on one charge.

This carriage has been sold and shipped to Germany to be used as a model for building similar ones over there.

This question of electric vehicles is attracting the atten-

tion of the large carriage and bicycle manufacturers, many of whom are building such vehicles, and with a battery such as is now produced capable of very heavy discharges, and with good roads, it would appear as though the business would soon assume large proportions.

The use of electric launches is growing steadily, but not as rapidly as other applications. In this work light weight is not so important as for carriage work, but batteries for this work must have large capacity, as it is often necessary to make long runs before facilities for re-charging can be obtained.

The improvement in storage cells for this work is shown in the fact that the batteries on the launches which ran for three months at the Atlanta Exposition did not cost one cent for repairs, which was not the case with those used at Chicago, at the World's Fair. The battery used at Atlanta was the Chloride type.

NEWS AND NOTES.

AN ELECTRICWAY BILL FOR GOVERNMENT LANDS.

It may not be generally known that the mountains and mountainous regions of the West are withheld by the Government from homestead entry, and are set aside as Forest Reserves or mountain parks. As these regions are usually supplied with large water powers or mountain streams, furnishing water at great heights, it is therefore much to be desired that the National Government should do all within its power for the reasonable encouragement of enterprises seeking to develop these water powers for the generation of electricity and its transmission to towns or cities, whether they be near or far.

The matter has been brought before Congress, and on Jan. 10 the House Committee on Public Lands reported favorably Representative Bowers', of California, bill to amend the act approved March 3, 1891, granting a right of way upon public lands for reservoir and canal purposes by adding thereto the following:

"Section 2 That the Secretary of the Interior be, and hereby is, authorized and empowered under general regulations to be fixed by him, to permit the use of right of way to the extent of 25 feet, together with the use of necessary ground, not exceeding forty acres, upon public lands and forest reservations of the United States, by any citizen or association of citizens of the United States for the purpose of generating, manufacturing or distributing electric power."

In California and elsewhere small towns and cities located in valleys can utilize electric light and power at a minimum cost if allowed the right of way across Government lands in the foothills of the mountains, as this bill permits. Secretary Hoke Smith says:

"I see no objection to the amendment suggested by the Commissioner, providing that right of way through forest reservations may be authorized under regulations to be adopted by the Secretary relative to the use of grounds for the purpose of generating and distributing electric power."

The bill when passed will be far reaching in its effect, for it will at once add to an electric power corporation assets of the very highest real estate value, and of a class such as but few electric companies of any kind possess, an absolute and wide right of way—in short, an electricway—with unquestioned title and patent from the Government. The effect and advantage of this feature in promoting the organization of such companies will doubtless be very great, as it will afford investors a real estate and property franchise whose value will not be solely one of future possibilities, as is usually the rule with other franchises.

SEEING WITHOUT LIGHT.

Under date of Feb. 10 the following cablegram has been received by the daily press from London:

"A most remarkable discovery has been made, according to a dispatch from Rome, in connection with the investigation of Professor Röntgen's new force in photography. Professor Salvioni, of Perugia, read a paper before the Rome Medical Academy on Saturday, in which he describes an optical instrument of his invention which enables the human eye, by means of the Röntgen rays, to see through anything which those rays can penetrate. It is said that Professor Salvioni produced his wonderful invention, and by its means physicians present were enabled to see the contents of a closed aluminum box.

"Unfortunately no explanation is given of the means used to make the hitherto invisible rays, perceptible by man's optic nerve.

"A London photographer has found that a convenient substitute for Crooke's tube is an ordinary incandescent electric lamp, in which the filament has been broken. This improvised Crookes tube and an ordinary house to house electric light current will enable any photographer to make Röntgen photographs on a small scale."

"RAYGRAPHS" OF THE KIDNEYS.

A special dispatch of January 29 from Vienna says: "Dr. Neusser, professor of medicine in the Vienna University, showed this afternoon, by means of photographs taken by Roentgen's newly discovered system, the presence and position of calcareous deposits in the liver and kidneys of a subject."

LEGAL NOTES.

MOTION TO ADVANCE THE BERLINER CASE.

A motion was made in the Supreme Court of the United States on Feb. 3 by Attorney-General Harmon, as special counsel for the United States, to advance the Berliner telephone patent case for an early argument in next term of the court, and Messrs. Fish and Storrow said they would not oppose it. The brief in support of the motion sets out that the suit is brought to obtain the repeal of the patent granted to the American Bell Telephone Company, as assignee of Emil Berliner, the alleged inventor, on the ground that the application for it filed in 1877 was not issued until 1891, it being unnecessarily delayed in the Patent Office, the assignee promoting said delay for his own interests and in fraud of the rights of the public, and in violation of his duty to the public; that said Berliner patent practically controls the art of telephony, and having been thus delayed until 1891 (the patent of Alexander Graham Bell for the speaking telephone expiring in 1893), operates to prolong the control of the art of telephony for fifteen years beyond the time when, by the expiration of the said Bell patent, such control should rightfully cease; that said patent was granted by the Commissioner of Patents without authority of law, being for the same invention for which patent had been granted to the same applicant in November, 1880.

"If the United States," the brief says, "is right in its contention that the Berliner patent, for the reason stated, ought to be repealed, it is of great importance to the public and the repeal should not be unnecessarily delayed."

PERSONAL.

KORNETZKE—RACH.

By an order of the Court on January 18th, the name of Mr. Gustav A. Kornetzke, of Schenectady, N. Y., was changed to that of Christian G. Rach. Having been connected with the Edison underground tube work since its inception in 1880, Mr. Kornetzke is well known, and a general favorite among the managers and electrical staff of most of the Edison stations throughout the country. Mr. Kornetzke is now the manager of the Underground Tube Department of the General Electric Company, at Schenectady.

MR. JAMES MENZIES has succeeded Mr. J. E. Torbert as general manager of the Mexican Telephone Company. Mr. Menzies was assistant superintendent of the central division of the New England Telegraph and Telephone Company. Early in January he was released by the New England to the Mexican company.

MR. H. J. ODELL has resigned as general manager of the Concord (N. H.) Land and Power Company.

MR. C. D. WARNER has severed his active connection with the Standard Electric Time Company of Waterbury, and is succeeded by J. O. Lyman as superintendent.

SOCIETY AND CLUB NOTES.

CHICAGO ELECTRICAL ASSOCIATION.

The meeting of the above association, to be held on Friday, Feb. 21, at 1737 Monadnock Building, will hear a paper by B. S. Summers, chemist for the Western Electric Company, on the "Outlook for Electro Chemistry."

AM. INST. ELEC. ENGINEERS.

It is proposed to incorporate the Institute, which has now been in existence since 1884, and which has reached a membership of 1,000. Notice duly given by a majority of the council has been issued for a regular meeting, to be held in this city on Feb. 26 to consider the proposition to incorporate under section 5 of the membership corporations law of this State.

Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

THE NEW RUSHMORE ARC PROJECTORS.

THE RUSHMORE DYNAMO WORKS, who have for years manufactured searchlights and electrical apparatus for marine use, have in the last year brought out a complete line of high-power-lens mirror projectors, or searchlights, for commercial marine and naval use.

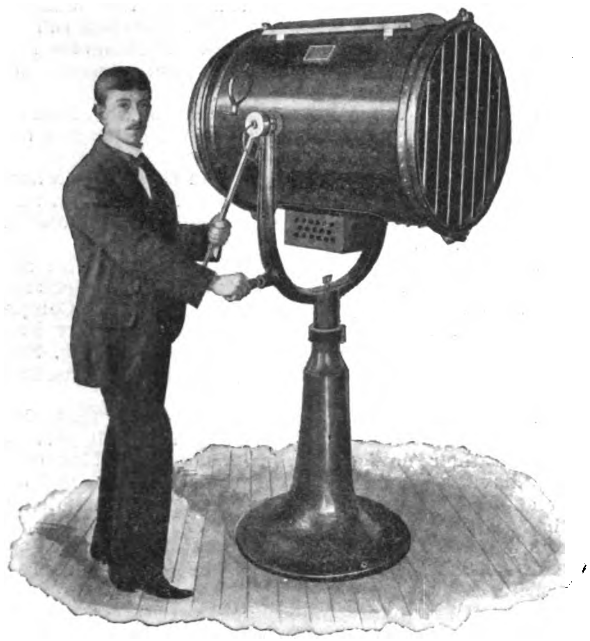


FIG. 1.—RUSHMORE ARC PROJECTOR.

In the common so-called searchlights there is an ordinary locomotive headlight reflector fitted with an arc light in place of the oil wick. This reflector absorbs nearly all the light and cannot be built for high power, as it soon rusts away.

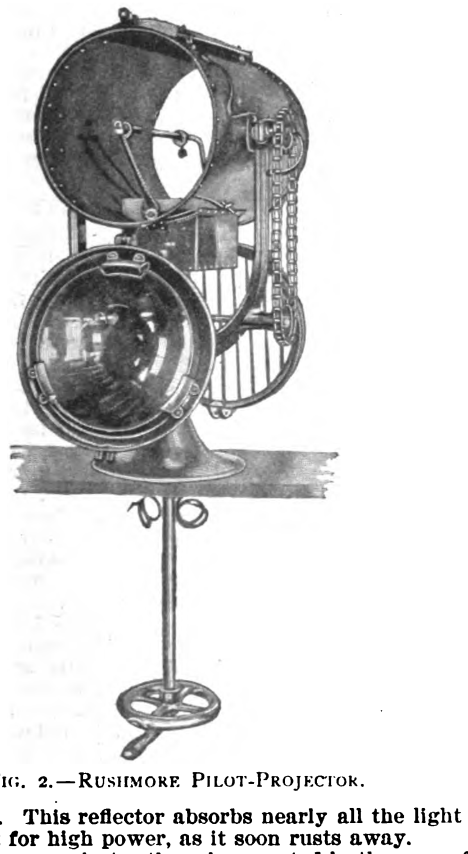


FIG. 2.—RUSHMORE PILOT-PROJECTOR.

In the Rushmore projector there is mounted in the rear of the cylinder, as shown in Fig. 2, a large silvered lens, and a special focusing lamp lies in a case in the bottom of the cylinder, which is entirely empty, except for the slender carbon holders, which cast no shadow, and the carbons are so placed that all the light generated is thrown directly upon the mirror and is projected forward in a perfectly straight beam. This arrangement permits the use of a powerful current in the arc without risk of heating, and by recent tests it has been shown that the projected beam has a power of over 1,000,000 candles per ampere in the arc.

Fig. 1 shows the plain projector as used in the Navy and on large lake and ocean steamers. Fig. 2 shows the pilot-house light fitted with the new controlling attachment for operating from within the pilot house. This is the small pilot-house light with front and back door open, showing the lens and lamp, from which it will be seen that it is easily cleaned and supplied with new carbons.

Fig. 3 shows the new Rushmore aplanatic lens with reversed image. This new lens has the remarkable property that by a slight movement it causes the beam to be spread over a wide area, thus dispensing with the heavy and costly diverging lenses used in the Navy.

Another type of this projector is fitted with a small motor in the base, so that the light may be placed at any point on the ship and the beam thrown in any direction by means of a small electric controller in the pilot house, thus doing away with all mechanical connections.

This apparatus is designed for the roughest commercial use, and is free from all complications. Quite a number of these projectors are already in use and giving entire satisfaction.

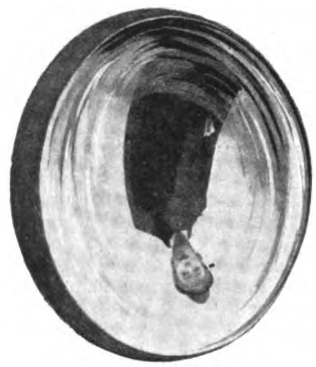


FIG. 3.

The Rushmore works have a complete lens-making plant, with which they have reduced the cost of lenses and made the cost of the best projectors but little more than the old-style headlights.

HOGAN BOILERS IN THE SEA CLIFF, L. I., STATION.

The Franklin Electric Illuminating Company, Sea Cliff, N. Y., which is considered to be one of the best equipped lighting stations on Long Island, is using the Hogan water tube boiler. The plant was started up in June, 1895, and ran continuously to Dec. 13, 1895, when the fires were drawn and the boiler examined. The report of the examination reads in part as follows: "The manhole covers of steam and distributing drums were removed, and the boiler was found perfectly clean throughout, not a particle of scale or deposit being visible. The same copper gaskets forming joints of manhole were used again and the joints were perfectly tight at 125 pounds pressure when steam was raised." This station lights the towns of Sea Cliff and Glen Cove, and careful investigation shows that the coal expenses per day of fifteen hours with the Hogan boiler is $2.50. The Hogan company have secured a contract from J. B. McDonald, contractor for the Jerome Park reservoir for a 500-horse power boiler at Fordham, N. Y., and have also recently installed boilers in the Lehigh Valley silk mills, at South Bethlehem, Pa.

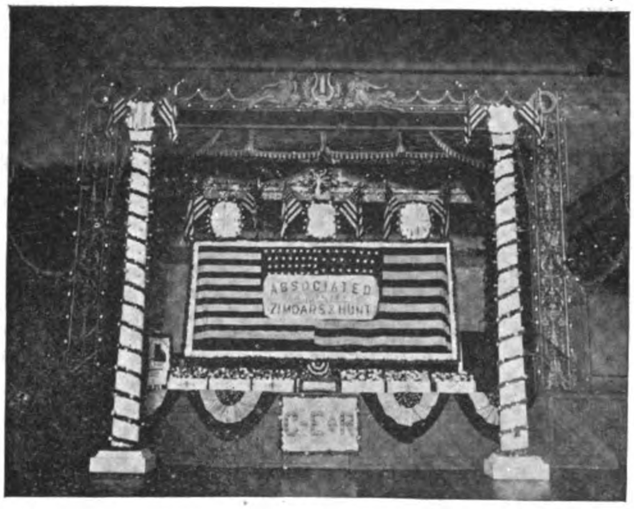
CUTTER'S HANDY WIRING TABLE.

Mr. George Cutter, The Rookery, Chicago, has issued a very neat and useful little pocket pamphlet as above, containing definitions, resistances, carrying capacities, voltage drop and incandescent wiring tables. Its cost is only 25 cents. The cover is paper, cloth stiffened.

MR. MYRON KNAPP, of Chicago, has been in the East for the past week or two, in the interests of his new company, the Graphite Rheostat Co. Mr. Knapp reports that this concern have made a distinct success of their apparatus and are as busy as possible filling orders. Several new agencies have been appointed in the East, and Mr. Knapp's many friends are wishing him the best of success.

DECORATIONS AT THE ZIMDARS AND HUNT ANNUAL BALL.

On the night of the 16th of December, the employees of the firm of Zimdars & Hunt, the well-known firm of electrical engineers and contractors, held their second annual ball in the Central Opera House in New York. The ball was a huge success in every way, and was of interest to electricians on account of the magnificent electrical display and decorations, which had been specially arranged by the employees,



ELECTRICAL DECORATION, ZIMDARS & HUNT.

who all helped after working hours to make the exhibit as complete as possible. Our illustration shows the large decoration at the end of the hall, which was the masterpiece of the occasion, and which was literally covered by large numbers of different colored lamps, controlled by switches, so that any desired effect of coloring and grouping could be produced at the will of the operator. In the lower left hand corner may be noticed a faithful portrait of a black cat, popularly supposed to be the mascot of the Zimdars & Hunt Co.

THE BALL & WOOD CO.

Among the New Year changes in business which will interest engine men we learn that Mr. F. H. Ball has sold his interest and retired from active participation in the management of the Ball & Wood Co., of Elizabeth. Br. Ball has been one of the officers of this company for a number of years, and desires to take up actively the profession of consulting engineer and mechanical expert, in which capacity he will still be connected with the company. His son, Mr. Bert C. Ball, also remains at the head of the draughting department.

The business of the Ball & Wood Company has been excellent during the past year, and has extended largely through the West since its Chicago office was opened a year ago. At present its shops are very busy executing the contract for a number of large engines for the Edison Electric Illuminating Company, of Paterson, and also orders for the New York and Brooklyn Bridge, Johnston Building, New York, Ellicott Square Building, Buffalo; St. Charles Hotel, New Orleans, and others.

ELEVATOR WANTED AT SPRINGFIELD, MO.

The Treasury Department, through the office of the Supervising Architect, is inviting proposals until Feb. 27, for all the labor and materials, and erecting complete, either a hydraulic or an electric passenger elevator, including pumps, tanks, piping, car, etc., for the United States Court House and Post Office building at Springfield, Mo. Prospective bidders may obtain additional particulars by addressing Hon. Wm. Martin Aiken, Supervising Architect, Treasury Department, Washington, D. C.

BERLIN IRON BRIDGE CO.

The Berlin Iron Bridge Company, of East Berlin, Conn., have just completed a very successful year. The shipments have been the largest in the history of the company and represented over one and one-half million dollars' worth of business. At the annual meeting of the stockholders, which was held at the office of the company on Thursday, Jan. 30, the following directors were elected. Chas. M. Jarvis, Burr K. Field, Geo. H. Sage, H. H. Peck of Waterbury, S. H. Wilcox of Brooklyn, N. Y., J. W. Burr and F. L. Wilcox. At the meeting of the directors the following officers were elected: President and chief engineer, Chas. M. Jarvis; vice president, B. K. Field; secretary, Geo. H. Sage; treasurer, F. L. Wilcox; manager of highway bridge department, D. E. Bradley; assistant to the president, E. W. Stearns.

WESTERN NOTES.

The Farr Telegraph and Construction Company of 342 Dearborn street, Chicago, are putting themselves in shape to furnish all telephone companies throughout the country with magneto bells, extension bells, receivers, induction coils and all telephone supplies at wholesale prices. Their motto is "quick sales and small profits." They will be glad to receive applications for their catalogue.

Mr. William H. McKinlock, president of the Metropolitan Electric Company, is in the East looking after the interests of the company.

The Wisconsin Electrical Construction Company, Milwaukee, report a nice business in general electrical supplies, and they also carry a fine stock of the newest designs of gas and electric fixtures in their extensive show rooms.

The People's Electric Company of Madison, Wis., a newly organized company, are selling agents for the electrical machinery manufactured by the Northern Electrical Company of Madison, Wis., Paiste specialties, Bryant & Hart switches, Grimshaw and Raven Core wires, Columbia lamps, Standard telephones, Badger electric railway goods, and general electrical specialties.

The Metropolitan Electric Company report that they are still receiving letters of congratulation from all parts of the country on their new mammoth catalogue. This catalogue seems to have taken the electrical trade by storm, and one and all pronounce it the largest and most complete catalogue that they had the pleasure of receiving. This company report the business outlook for '96 to be very encouraging.

The Standard Boiler Company of Chicago report a good business during the past year. They have moved into their new offices, 1120-21 Marquette Building. These boilers are built by the Link-Belt Machinery Company of Chicago, who have put in new and improved machinery for their manufacture, reducing the prime cost as well as making the various parts interchangeable. During the past year a number of fine plants have been installed, amongst others being 4,000 H. P. for the North Chicago Street Railroad Company at their new power station at Hawthorn avenue; 500 H. P. for the Cincinnati Edison Company; 600 H. P. for the Western Electric Company at their factory in Chicago, and various others. They report prospects for the coming year as good.

The Forest City Electric Company is a new Cleveland corporation. The purpose is to make and deal in all kinds of electrical machinery and apparatus. The capital stock is $25,000 and the incorporators are William B. Cleveland, Robert N. Lowe, F. H. Neff, W. H. Wherry and Walter G. Cleveland.

NEW ENGLAND NOTES.

The Pope Manufacturing Company of Hartford present the eleventh edition of their calendar pads in a form somewhat improved over that of preceding years. There are the usual quotations from Columbia users, but they take up less room than formerly, giving more space to the memorandum part of the pad. The illustrations take the form of vignettes, and are more numerous than in former years. A new feature with this year's calendar, and one which will readily find favor with those who ride bicycles, is the addition of information as to the moon's phases, so that engagements may be made as far as a month ahead for full-moon riding. We understand that these calendars may be procured, as usual, on the remittance of five 2-cent stamps.

The Graham Equipment Company of Boston have mailed to their friends one of the large-sized postal cards for which they are famous. The reverse of the postal contains a half-tone cut of the steel-frame car made by this company, while below is a very compact calendar of the entire year.

The Samson Cordage Works have issued a very pretty calendar, illustrating the destruction by Samson of his friend, the lion, while just below is a line advertising their spot cord.

Randolph, Mass.—The Randolph Electric Light Company, Randolph, Mass., are increasing their steam plant by the addition of a 160 H. P. tandem compound condensing engine from the Ball Engine Company of Erie, Pa.

NEW YORK NOTES.

Adams, N. Y.—The Adams electric light plant has been bought by Mr. R. F. Steele.

The Standard Air-Brake Company have found it necessary to remove to more commodious quarters, and are now located in the American Surety Building, 100 Broadway, New York.

THE ELECTRIC APPLIANCE COMPANY have just prepared a special catalogue of the "Paiste" specialties, listing a complete line of Xntric switches, Paiste sockets, cutouts, etc., together with a special net price list on same. They will be glad to send this catalogue on application. It makes quite a valuable list for reference, as considerable of the material has not been previously catalogued.

NEW YORK NOTES.

THE NIAGARA ELECTRIC CHEMICAL COMPANY has been incorporated with the Secretary of State to manufacture chemicals and chemical products. The capital is $100,000. Directors: Hamilton Y. Castner, of London, Eng.; Jacob Hasslacher, of New York City; Franz Roessler, of Perth Amboy, N. J., and William A. Haman, of Mount Vernon. The company will rent its power at Niagara, and is negotiating for a factory site. At present its manufactures will be confined to sodium and peroxide of sodium. The temporary office is at 73 Pine street, New York.

THE BAECHTOLD & PARKER ELECTRIC CO., 79 Washington Street, Brooklyn, have established, in connection with their electric light business, a department for the manufacture of a full line of standard types of street car commutators, which they are prepared to furnish in quantities. The previous extensive experience of the members of this company gives them an acquaintance with the peculiarities of all makes of railway armatures and commutators, and thus qualifies them for prompt and accurate work. The facilities for manufacturing have been improved, and in addition to general repair work, the company is prepared to take care of special work.

MR. M. R. RODRIGUES, 19 Whipple Street, Brooklyn, maker of "Premier" products, has recently added a Bliss power press to the other tools in his shop.

R. B. COREY & CO., of New York, have recently sold, through Messrs. E. H. Foerst & Co., of San Francisco, 325 Bergmann ornamental arc lamps for use in the Parrott Building, that city. Messrs. Foerst have also ordered for this building 7,000 Columbia incandescent lamps, and switchboard and panels of special design, by Bergmann & Co., of New York.

THE STANDARD PAINT CO., of New York, have just made an interesting shipment of their well known goods, P. and B. armature varnish and tape, for use on the new electric railway at Cape Town, Africa, which is already using considerable quantities of P. and B. goods. They have already made large shipments of their products to mining companies for electric plants in Matabele Land, and not a little of their special P. and B. paint for preservative purposes is now being used by various companies in Delagoa Bay. What further proof is necessary of the excellent qualities of P. and B., and the energetic management of the Standard Paint Company?

MR. GEORGE F. CHISM, formerly with the Standard Engineering Company, of Albany, N. Y., is now with Mr. Le-Grand Brown, of Rochester, N. Y. Mr. Brown is making a specialty of electric railway work, and Mr. Chism will direct his attention to the power plant department.

MR. W. H. McKINLOCK, President of the Metropolitan Electric Company, Chicago, is still in the East, and has closed some good business for his company.

THE PINKNEY-TOOMEY ELECTRICAL COMPANY has been formed in Jersey City, to make electrical instruments, supplies, etc. A. J. Booth is president. T. Sullivan, first Vice-President; J. Nolan, second Vice-President; F. Pinkney, Treasurer; J. Toomey, Secretary; R. Ingraham, Manager.

THE BIRDSALL ELECTRIC MANUFACTURING COMPANY, of New Rochelle, N. Y., has been formed, with a capital stock of $10,000, by Theodore Birdsall, of that place, and S. K. Johnson and Bryce Marr, of New York City.

THE FACTORY of Robert Edwards & Co., makers of electrical goods in north New York, was badly damaged by fire last week, the loss being put at $25,000, with insurance for $15,000.

THE FLEMING-SPENCE COMPANY, of this city, have made the H. N. Bates Machine Company of Boston their New England agents for their new and successful alternating arc lamp. The Fleming-Spence Company have some excellent reports on the working of their lamps on low frequency currents, as well as on high.

"We prize every copy highly, and cannot afford to lose an issue of so valuable a paper."—Clark Bros., electrical contractors, Berkeley, Cal.

THE VITRIFIED TERRA COTTA CONDUIT.

One of the exhibits at the annual convention of the North Western Electrical Association, that created unusual interest, was the vitrified terra cotta conduit of Mr. John T. McRoy, 36 South Clark Street, Chicago. The material used in its construction is shale, which is thoroughly ground and rendered free from all rough particles. During the process of manufacture the terra cotta is subjected to shrinkage to such a degree that a perfectly dense mass is secured, thereby rendering the conduit, when finished, absolutely non-porous. Not only is the terra cotta vitrified throughout, but all surfaces, both interior and exterior, are glazed as an additional precaution against moisture. The interior of the ducts being finished perfectly smooth, with rounded edges, there are no projections to impede the drawing in of the cable. The conduit is manufactured in multiple duct form of any desired number (from one to twelve) and cable capacity. The section lengths are about six feet. As the use of cement or concrete is unnecessary, the services of high priced artisans are not required. The conduits can be installed by comparatively unskilled labor at any season of the year.

SIGNALLING EXTRAORDINARY.

DURING some recent experiments with a view to determining the maximum rate of mechanical transmission by his system of machine telegraphy, Mr. Patrick B. Delany succeeded in producing over an artificial circuit of 250 ohms and 2.95 microfarads, with 115 volts, perfectly legible signals at the rate of 8,000 words per minute. Through 650 ohms the signals were readable, but faint.

This speed required the perforated tape to pass through the transmitter at the rate of 27½ feet per second, and deliver over 2,500 impulses per second at the receiving end of the line. A specimen of the received record may be seen at this office.

SPECIAL LOCAL EDISON EXHIBIT FOR THE MAY EXPOSITION.

One of the most attractive and instructive exhibits at the forthcoming Electrical Exposition will be that of the Edison Electric Illuminating Company, of New York. This display will occupy a space of over one thousand square feet, and will comprise a complete demonstration of the applications of electricity for domestic purposes. The most improved methods of house lighting will be shown in detail, also electric heating, and cooking by electricity. This will be the first time that such a practical exhibition has been made of the many uses to which electricity can be applied in the home, and the understanding of the visitor will be further enlightened by a well arranged display of the various kinds of apparatus employed, all of which will be explained by those in charge of the exhibit. It is safe to predict that, however interesting other exhibits may be, this will be crowded all the time. A large number of other fine displays are already promised and arranged for. All in need of information as to the exhibition should address at once Mr. Clarence E. Stump, the general manager, at 136 Liberty street.

THE NATIONAL UNDERGROUND CABLE COMPANY have opened offices at Nos. 16 and 17 Times building, New York, and are now manufacturing underground cables both for high and low tension. These cables will be covered with the highest grade paper insulation, will be made in all sizes and for all purposes. Our old friends, the National Conduit Manufacturing Company, who are widely known as the largest and most successful contractors for laying underground conduit in this country, own the controlling interest in this company, and have already secured many orders for highly insulated cables from a number of the most important telephone and electric light and power companies. These cables will be manufactured in the factory hitherto occupied by the Norwich Insulated Wire Company, and under their patents. With the excellent reputation of the National Conduit Company, and the well-known high quality of the cable, it is safe to say that success will follow them in their new enterprise.

THE WATERTOWN (N. Y.) STEAM ENGINE COMPANY have recently sold to Russell & Co., of Penn Yan, a 300-horse-power steam plant, comprising a duplex slow speed, double valve automatic engine with two return tubular boilers of 150 horse-power each. The contract was taken under very short notice and installed complete under a contract to forfeit $25 for every day of delay and receive a like premium for every day gained. The plant is for the electric lighting system of the Penn Yan Electric Light Company.

SOUTHERN NOTES.

HANNE BROS., Jacksonville, Fla., in placing their excellent wire reels on the market, have met with much encouragement. They have sent the reels out on thirty days' trial, and before the time due, the invoice was discounted, a sure sign of satisfaction. Employees of telegraph and telephone companies like the reels very much, and are bringing their persuasive powers to bear on the respective purchasing agents.

NEW ENGLAND NOTES.

W. B. W. WELLS, who is well known to electrical people from his connection with fire signal work, has been appointed Superintendent of Streets for the city of Boston. He is a graduate of Harvard, class of '84. He is at present treasurer of the Boston Automatic Fire Alarm Company.

THE WILIAM A. HARRIS STEAM ENGINE COMPANY, of Providence, R. I., has made an assignment to ex-Governor A. O. Bourn and F. A. Harris, with liabilities of $64,000 and assets estimated at $200,000. The trouble is attributed to the scarcity of ready cash.

BRUNSWICK, N. J.—The power house for the Brunswick Traction Company, at Milltown, N. J., will be furnished by the Berlin Iron Bridge Company, of East Berlin, Conn. The engine room will be 64 ft. long, and 85 ft. wide, and the boiler room 45 ft. wide, and 48 ft. long. The side walls are of brick and the roof trusses of iron.

THE BERLIN IRON BRIDGE COMPANY, of East Berlin, Conn., have just completed, for the Newport News Foundry Company, at Hampton, Va., a large foundry, 40 ft. wide and 160 ft. long, the central portion being controlled by a travelling crane. This is one of the best and most modern foundries of the Southern States.

PHILADELPHIA NOTES.

FRANK H. STEWART & CO. have dissolved, by mutual consent, Mr. P. Logan Bockins retiring on account of ill health. The busniess will be conducted by Mr. Frank H. Stewart, under the old name. He will carry a full line of general electrical supplies. They are at present making a specialty of knife switches at cut prices, which they are advertising on another page.

THE STOREY MOTOR AND TOOL COMPANY, of Philadelphia, has issued is very neat and tasteful catalogue of its ingenious motor specialties, several of which have lately been illustrated and described in these pages. Mr. Storey has done notable work in the motor field and is entitled to much credit as well as a large share of the business.

WESTERN NOTES.

THE ABBOTT ELECTRIC AIR COOLING AND PURIFYING COMPANY has been formed at San Francisco, with a capital stock of $1,000,000 by H. W. Abbott, D. G. Depter, A. S. Brackett, M. Strouse, and H. C. Birbee.

MR. J. S. WILSON, Superintendent of the American Circular Loom Company, Boston, Mass., visited their Chicago office last week to confer with their Western agents, Messrs. Brooks and Chandler, on business matters. The prospects of this company's doing a large trade during the year are very encouraging.

LOVELL, MICH.—Sealed proposals for furnishing an electric light and power plant for the city, to consist of 1,000 incandescent lights, 60 arc lights and 100 H. P. for motor service, will be received by Hon. C. Bergin, President of the Board, until 8 o'clock P. M., Feb. 18, 1896. The plant will be run by water wheels located 8 miles from the city. Copies of the specifications can be had by applying to Humphrey & Carr, Engineers, 22 Benedict Building, Detroit, Mich.

THE ELECTRIC APPLIANCE COMPANY have issued and distributed a very attractive calendar for 1896. They have combined with the calendar a carefully prepared moonlight schedule for the entire year of 1896, making the calendar doubly useful as well as ornamental.

THE MANISTEE (MICH.) ELECTRICAL SUPPLY COMPANY has been formed by J. O. Nessew, J. S. Mundy and others, with the object of making electrical apparatus. Fifty men will, it is said, be employed.

THE TRADESMEN'S BANK BUILDING, a large and handsome block being erected in Pittsburg at the present time, will be lighted by electricity from its own plant, which consists of Ball engines, built by the Ball Engine Company, Erie, Pa., direct connected to Westinghouse dynamos.

MR. LUTHER STIERINGER, Consulting Electrical Engineer of the late Atlanta Exposition, was a visitor to Chicago for a few days last week.

MR. MAX A. BERG has resigned his position as manager of the Chicago office of the Ohio Brass Company, and has accepted a responsible position with the same company, at their head office, and works, Mansfield, Ohio.

THE GATES ELECTRIC MANUFACTURING COMPANY, with offices in the Monadnock Building, has made an assignment to the Chicago Title and Trust Company for the benefit of its creditors. The assets are said to be $17,000 and the liabilities about $8,500. The president of the company is J. Holt Gates. The attorney for the assignee said the company had a valuable plant and a number of contracts on hand, but it was unable to make collections. He said the creditors would be paid in full.

MR. W. F. PARISH, general sales manager of the Racine Hardware Co., Marquette Building, Chicago, reports that the number of sales of the engines manufactured by this company during the year 1895 was highly satisfactory. They have sold a large number of their engines for isolated lighting plants throughout the country, and also for the lighting of excursion boats and general ship lighting work. There has also been a considerable demand for small units from 1 H. P. to 15 H. P. for use in mines. They are now making tests of a new design of governor, which will greatly improve the governing operation of their engines, and its work will be such as to insure the closest regulation that has yet been attained, and will render these engines specially adapted for isolated lighting plants. The company have a large and varied stock of vertical and horizontal engines at their works in Racine, Wis., and are now also building center crank horizontal engines of 35 H. P. and upwards.

EMERSON MOTORS.—The trade outlook for 1896, as viewed by the Emerson Electric Manufacturing Company of St. Louis, is extremely encouraging. Not only is their new single-phase alternating current power motor creating great interest, followed by numerous orders from the alternating current fraternity, but their standard line of knife switches and other specialties interest all parties, and their order-book is showing this appreciation in a substantial manner.

WATER POWER UTILIZATION AT OGDEN, UTAH.

The Hon. Frank J. Cannon, of Ogden, Utah, Senator-elect from Utah, makes public the announcement that the final arrangements have been completed in the East whereby the Pioneer Electric Power Company will be able to sell bonds to the amount of $1,500,000 and thus complete the work of utilizing the power in Ogden River canyon. The statement is also confirmed by C. K. Bannister, the engineer of the company.

In 1890 C. E. Mayne organized a local company to develop the power in the river above the city. After an expenditure of $20,000, mostly home capital, Mayne abandoned the scheme and went to San Francisco, but returned in 1893 and resumed the undertaking, but again failed to secure the funds to complete the work. The present company was organized in the fall of 1893 and has been prosecuting the work steadily ever since, but has been hampered by the unwillingness of Eastern capitalists to invest money in enterprises in a Territory. The admission of Utah as a State and the friendliness of the State Constitution to outside investors has aided materially in the success of the Pioneer company in floating its bonds.

The pipe line, power house and electrical machinery for the development of 5,000 horse power must be completed by Sept. 1 of this year and the other 5,000 soon after.

The contract for laying the steel and wooden pipe, which is 30,000 feet in length, has already been let, and the work of laying will begin at once, as there are now two miles of the trench completed. The wooden pipe, six feet in diameter in the clear, will be constructed on the ground and laid as fast as it can be put together, part of the material having already arrived. Bids are to be called for in February for the construction of a large reservoir dam in the valley above the canyon as a preliminary to the development of the remaining 5,000-horse power.

The company is already in possession of contracts with manufacturers by which a number of factories will be located as soon as the company can furnish the power.

AN IMPORTANT EXTENSION OF THE WEST END SYSTEM.

The West End Street Railway Company of Boston has just placed an order with the General Electric Company for four 1,200 K. W. generators and one 1,500 K. W. generator, making a total of 6,300 K. W. in five units. The General Electric Company has also secured an order from the Cataract Construction Company for one 500 K. W. rotary convertor for use in supplying current to the Buffalo and Niagara Falls Railway Company.

Department News Items will be found in advertising pages.

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ELECTRIC TRANSPORTATION.

CAN ELECTRICITY SUPPLANT THE STEAM LOCOMOTIVE ON TRUNK RAILWAYS?—I.

BY

Wm. Baxter, Jr.

THE wonderful rapidity with which the electric motor has invaded the street railway field has created a very general belief that it will not be long before it will enter the domain of the steam locomotive and repeat on a larger scale its extraordinary successes of the past. The general run of men who base their opinions wholly upon what they see and have no technical knowledge by which to be guided, very naturally take it for granted that if electric motors can propel small cars with so much success as to replace horses and cables, that there is no reason why they should not be able to do equally as well with larger cars; and, therefore, that the only thing that can delay the electric invasion of the steam railroad field is the willingness of the managers of these roads to make the change.

The great majority of semi-informed engineers who believe that it is always wise to boom new engineering developments and who are not over-particular about their engineering reputations, were not slow in the early days of electric railways in coming to the front with the most positive assertions to the effect that the locomotive was doomed to oblivion and would only be known as a museum curiosity by the end of the century. These men were not the only enthusiastic advocates of the newcomer. A number of men of wide reputation did not hesitate to assert in the strongest kind of language that the days of steam were numbered. One of the best known electricians, when interviewed on the subject said: "It will displace it if economy, as well as speed and safety, is a factor of locomotion, not because it will make easily a speed of a hundred miles an hour while steam strains itself to make sixty, but because it will get one horse power out of from one to two pounds of cheap coal, while out of six pounds of dear coal a locomotive engine can only get that same one horse power. It will displace it because it will be cheaper."

The language quoted above, as well as several other statements of the same general tenor by men of considerable prominence as engineers, formed the basis of the arguments by which it was sought to prove that electricity would soon be monarch of all it surveyed. Now, as a matter of fact, if electricity is to depend wholly upon the difference in coal consumption between locomotives and large triple expansion stationary engines to obtain a foothold on trunk line railways, it may as well give up the contest at once. Not because the difference in coal consumption is not as great as has been claimed, but because the total cost of fuel forms but a small percentage of the cost of operating a railway system; therefore, even if the entire amount were saved the reduction in running expenses would not be so great as to enable electricity to revolutionize present methods.

It is my object in this article to present the merits upon which electricity can base a claim of superiority, in a fair and impartial manner; therefore, no assumptions will be made that cannot be substantiated directly or indirectly by actual records.

Whenever a controversy arises in any field it is but natural that the most enthusiastic advocates on both sides of the question should lose their judgment and make claims that are, to say the least, somewhat biased in their favor. This has been the case with the majority of writers on both sides of the question of the relative economy of locomotives and stationary engines. There is no such difference in coal consumption between the best type of triple-expansion engines and locomotives as is claimed in the above quotation. The stationary engine has never developed one horse power per pound of coal per hour. An efficiency of two pounds of cheap coal per horse power hour is as much as any conservative engineer would claim. On the other hand, the locomotive is not the great steam annihilator it has been represented to be; on the contrary, it is one of the most economical of non-condensing engines when run at a high speed.

These facts were well known to experts in steam railroading, and they were not slow in showing that the statements made by the advocates of the electric motor were exaggerated. In fact, they were a little too zealous in their efforts to make the best possible showing for the locomotive and went so far as to give the best recorded results as the average performance.

Numerous articles have been published in engineering journals devoted to the interests of locomotives, in which it has been claimed that the coal consumption in some cases is as low as 2½ lbs. and that an average of 3 or 3½ could be safely taken as well within actual every-day results. Such claims, however, are just as far out of the way in favor of steam as the assertions of the advocates of electricity were in the opposite direction.

THE WESTINGHOUSE—BALDWIN ELECTRIC LOCOMOTIVE.

The first of the electric locomotives built jointly by the Westinghouse Company, and the Baldwin Locomotive Works has arrived in Pittsburg and will be used for heavy hauling in the yards at East Pittsburg.

It is the size of a common box car, being 30 feet long. It is built entirely of steel, and is mounted upon eight wheels, 42 inches in diameter. It will be geared for 800 horse power, but can for a short period exert 1,600 horse power. At the former power the new locomotive can draw a loaded freight train 40 miles an hour, and at the latter power 80 miles. It is operated by one man, in a way similar to the common trolley. The cost is said to equal that of a steam locomotive, and the weight of this first one is 60 tons.

air brakes the seven eight-wheel combination postal and passenger cars of the Brooklyn Heights Railroad Company. These cars weigh over ten tons each, exclusive of passengers and mails, and travel over routes having very heavy grades, so that a brake more powerful than the ordinary hand brake was absolutely necessary for safety and speed. The speed of these postal cars may occasionally rise to such a point as to make the quick and certain application of brakes important, and the fact that the "Standard" air brakes have been chosen for this service is significant. It is worthy of note, by the way, that with the Standard air brake there is said to be little difficulty in using the sand boxes. In cases of emergency, the motorman throws his handle completely over and sets the brake and can then devote his entire attention to properly sanding the track. The company now offers a special device by which with one turn of the handle sand is run out and the air brake applied.

The car shown in Fig. 4 is in service on the Pasadena and

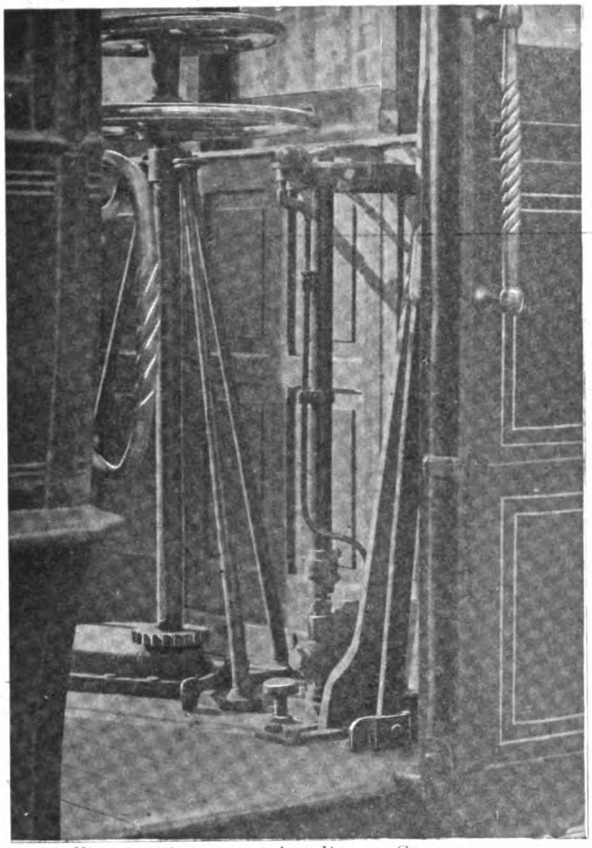


FIG. 4.—STANDARD AIR BRAKE CONTROLLER.

Los Angeles Railway Company's route. There are two forty-horse power motors of latest design used, making eighty-horse power per car. Every car is equipped with the "Standard" air brake, a necessity, since the grades range from 3 to 7.6 per cent. In this connection it is interesting to know that the Standard Air Brake Company has just received the third order from the management of that road. This fact speaks for itself, especially as the original brakes are in their second year of operation.

We may also mention another recent application of the "Standard" brakes, and that is on the cars of the Washington, Alexandria & Mt. Vernon Railway Co. This road will operate its cars at very high speeds, up to forty-five miles per hour, on account of which, and of the motor and truck arrangement, the Standard Company is using its geared compressor type. These compressors are not mounted on the motor axles, but on the small wheel axles of the Brill maximum traction trucks. A high efficiency is said to have been developed by these compressors in recent trials. These are but a few of the latest application of "Standard" air brake, the use of which is rapidly extending, not only in the United States, but also abroad, whither a large number of equipments have been recently shipped.

AN ELECTRIC RAILWAY BRIDGE FOR NIAGARA.

Senator Ellsworth has at Albany introduced a bill to incorporate the Lewiston Connecting Bridge Company, to construct a bridge on the east bank of the Niagara River in the town of Lewiston, Niagara County, south of the village of Lewiston, to some point in Canada, on the west bank of the Niagara River. By the bill the company is authorized to lay tracks and operate a railroad by electrical or any power other than locomotive steam power and to lay pipes to convey gas and water and cables to transmit electricity or other motive power. The capital stock is to be $200,000, divided into $100 shares. The stock may be increased to $500,000. Charles H. Smyth, of Clinton; John T. Mott, of Oswego; Joseph S. Bryant and John M. Bostwick, of Buffalo, and T. Hotchkiss, of Lewiston, are named as commissioners to locate the bridge.

TROLLEY ON GETTYSBURG BATTLEFIELD.

In the United States Supreme Court Justice Peckham has handed down an opinion sustaining the right of the government to condemn portions of the Gettysburg battlefield for public use, which has been acquired by the Gettysburg Electric Company to lay their tracks upon.

The opinion of the court dealt with the case involving the right of the government to condemn the real estate of the Gettysburg Electric Railway Company as a part of the National Park ,located upon the Gettysburg battleground. The court below (Judge Dallas, of Philadelphia) had decided that the act of Congress authorizing the establishment of the park in so far as it applied to the condemnation of private property was unconstitutional and that there was no right under it to condemn. The proceedings to condemn were begun under authority of an act of Congress appropriating money to pay for the ground.

TWO CENT PER MILE RATE IN OHIO.

The numerous electric railrods in northern Ohio are causing the steam roads a great deal of anxiety by taking from them short haul freight and passengers. The Erie company has taken the bull by the horns and decided to reduce the passenger rates in the region of Youngstown and Warren to the level of the fares charged by the competing electric lines there. The Cleveland, Canton and Southern Railroau has already made a reduction of 2 cents per mile on certain round trip tickets.

CONNECTICUT TROLLEY PARALLELS.

The Norwalk City Council voted on Jan. 18 to give the Norwalk Tramway Company permission to extend its trolley line to Westport, a distance of about three miles. When that line is completed there will be only a gap of about four miles between the Norwalk Tramway Company's system and the system of the Bridgeport Traction Company, now reaching to Southport, and with that gap eliminated the New Haven Steam Company's main system will be paralleled by trolley roads for a distance of about twelve miles between Bridgeport and Norwalk and South Norwalk. This is an important part of the New Haven company's line for local travel. Figures presented by the latter corporation to the State Legislature at the last session showed, for example, that between Bridgeport and Southport during six months the local passenger travel had decreased by 5,131 passengers, or about 25 per cent., as compared with the year 1894, when no electric competition existed. Between Bridgeport and Fairfield—somewhat nearer Bridgeport than Southport—the traffic during three test months of the same period fell off on the New Haven road 60 per cent., owing to the opening of the trolley line. The only chance probably of blocking the new lines is an appeal by the steam company to the Superior Court, which, under the general street railway law of the State, can rule that a parallel line is not demanded by public necessity or convenience.

An examination of the whole trolley system of Connecticut shows that the steam railroads of the State are now paralleled by trolleys for a distance of about 101 miles, and that about one-third of all the trolley roads parallel steam roads more or less directly. The New Haven steam road is paralleled about sixty miles, the New England road (controlled by the New Haven corporation) about twenty-eight miles, and the Philadelphia & Reading and New England about 13 miles. Trolley roads almost certain soon to be built or actually in construction now will add about thirty-four miles, of which sixteen miles will parallel the New Haven road, six miles the New England, and twelve miles the New London Northern. On the basis of last year's official figures of the results of competition on passenger traffic, the indications are, however, that the total loss of the steam companies by electric rivalry does not now exceed $100,000 a year as compared with the period before any trolleys had been built. In such a comparison it must be remembered that a large portion of the trolley parallels represent merely the substitution of electricity for horse power on all street railroads paralleling steam lines.

ELECTRIC LIGHTING.

THE NATURE OF THE X-RAYS.

BY WILLARD E. CASE.

IN the last number of "The Electrical Engineer" the writer described an experiment in which the rays emanating from a cathode terminal excited by an induction coil cast a shadow of the anode terminal upon a sensitive plate placed beyond the latter. The arrangement adopted is illustrated in the accompanying diagram, Fig. 1. A print of the shadow obtained on the sensitive plate is shown in Fig 2.

Another interesting fact observed, as already stated,

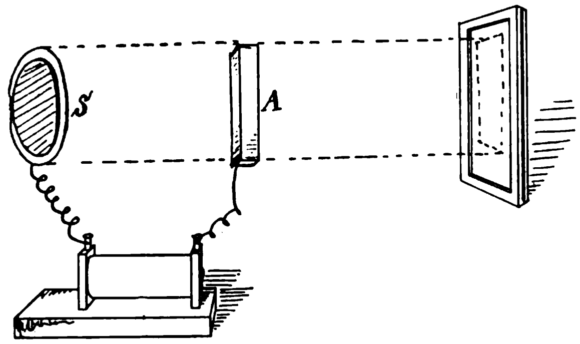


FIG. 1.

was that when a vacuum tube was placed in the vicinity of a condenser plate and sensitized photographic plate, the rays seemed to be deflected and an imperfect shadow of the object photographed was obtained. From these experiments it would appear that sensitized plates can be acted upon in any place in which vacuum tubes would glow. It is well known that a vacuum tube will glow when attached to the terminal of an induction coil with one wire only, or when placed between two condenser plates, even if solid objects surround it, such as wood, glass, etc. We know that vacuum tubes will glow at a long distance from the point of origin of the oscillations, so that photography

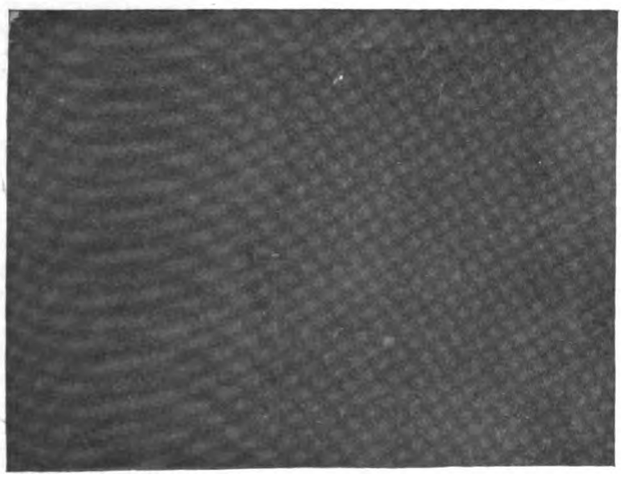


FIG. 2.

by this method is not limited to small distances, nor to any light which can be observed by the eye. The fact that the vacuum tube before mentioned deflected the rays and caused an imperfect shadow might tend to show that the vacuum was the path of less resistance for this electrical action.

This naturally raises the question whether or not the action is the electric oscillations described by Hertz or due to the cathode rays mentioned by Lenard, or due to the radiant matter so thoroughly investigated by Crookes. If it is due to what might be called the Crookes effect, or radiant matter, it naturally suggests itself to one's mind that many of his devices might be utilized for controlling this force, if the rays could be focused more thoroughly, and more immediate effects might be obtained.

Take, for example, Crookes' focused mirror tube. The bulb would be constructed of aluminum instead of glass, and the electrodes arranged after the Crookes method. The curvature of the mirror should be such that the focus would be outside of the tube, and the object to be photographed could be placed in the desired position. If the action is due to the Hertz effect, the rays might be focused by means of a lens made of pitch, such as he suggested and constructed.

The Röntgen method of photography which so astonished the world and opened up such tremendous fields for investigation has come upon us so suddenly that one can only make experiments, record them and give them to the world for what they may later prove to be worth. Within a month it has been discovered that hidden objects could be photographed with a new light, and within the same period other investigators have found that no light was needed.

Crookes, in 1879, in his lecture delivered before the British Association for the Advancement of Science at Sheffield, [1]stated that radiant matter in a vacuum tube when intercepted by solid matter, casts a shadow and that the radiant matter goes from one pole to the other in straight lines. From the experiments that I have made, heretofore described, it would appear that we have something analogous to the Crookes effect going on in the atmosphere, and if so, as we think is proved by the arrangements and photograph here shown and described, electrical energy can be transmitted from its source, the condenser plate, to the object to be photographed without light and its shadow thrown to a distance, where it may be photographed.

PHOTOGRAPHING HIDDEN OBJECTS BY THE ARC LIGHT.

BY

J. Hart Robertson

WHILE the scientific world to-day is agitated over Röntgen's discovery, it will, no doubt, interest many to learn that the more or less complicated apparatus, such as experimenters are now using, is not necessary to produce the results obtained by Röntgen.

The result of an experiment referred to further on shows that what have been called the X or cathode rays (at least as produced by high potential alternate currents) are not essential. It also demonstrates the fact that it is not necessary to use the vacuum bulb in producing Röntgen's effects, and also that what are known as magnetic lines of force are very closely allied to this subtle something that has the inherent power to penetrate substances that hitherto were supposed to be proof against every known force, except magnetism.

The semi-magnetic lines of force penetrate through different substances from which light is absolutely excluded, and have to a great extent the penetrating power of magnetic lines of force, only differing from these in so far as their power to pass through some media; or, in

[1]This lecture appears on page 189.

other words, whilst magnetic lines of force will seemingly pass through one substance as quickly as through another, these semi-magnetic lines of force will pass quicker through some media than through others.

This may be due, and probably is, to some, at present, unknown force, combined with magnetic lines of force, which produce a retarding effect on the same and cause them to take a more roundabout path through some substances than they otherwise would.

Experiments are now being conducted which may show that magnetic lines of force alone, when properly directed, will produce all, and more, of the effects which have been credited to the "X" or cathode ray.

In talking with an experimenter in photography, Mr. Guion Thompson, of Harrisburg, Pa., I suggested that an arc lamp would produce all the effects that the cathode rays have been credited with. To demonstrate this fact, one evening during the week ending Feb. 8, a temporary arc lamp, consisting of two carbon rods lightly clamped on a board, so that one could easily be manipulated by hand, were put in circuit with 25 storage cells and placed in a horizontal position, so that the box containing the sensitive plate could be placed over the arc.

The box, which was made of hard wood, one-fourth of an inch thick, with sliding cover on top, fitting into groves in same, contained, besides the sesitive plate, a piece of irregularly shaped ferrotype metal and a piece of ordinary glass, each of which overlapped the sensitive plate about one-quarter of its surface. These were placed in the bottom of the box. The box was filled with maroon-colored fabric and the cover slid tightly on. Pieces of brick were used at about two inches above the arc. Through a fuse burning out, the exposure only lasted one minute, but when the plate was developed it was seen that even with that short exposure the semi-magnetic lines of force had penetrated the box and left their impression on the plate.

One side of the plate showed the ferrotype metal exactly as it was, although the impression was faint. The part overlapped by the piece of glass showed that no effect whatever had taken place, and that the glass acted the same as when used with cathode rays, in so far as it interfered with the rays penetrating through it and reaching that part of the plate immediately over it.

As far as I am aware, this is the first time that an arc light has been used to produce this wonderful effect. There, no doubt, would have been some publication of the fact if it had been accomplished before.

The use of an arc allows of great possibilities being accomplished, as there is no necessity for any intricate apparatus, and the arc can be kept in one position, so that either a short or long exposure can be made without any trouble.

Possibly any substance can be penetrated by these lines of force, and all that will be necessary will be to have a longer exposure with some materials than with others.

GROWTH OF THE MANCHESTER, N. H., ELECTRIC LIGHT CO.

The business of the above corporation for the past year has been satisfactory. There has been quite a considerable increase in the gross earnings and a very good showing of net earnings. The calls upon the company for extensions and construction have been very large, especially in the street lighting and power departments. The addition to the property during the past twelve months consists of two 150-horse-power boilers, one condensing engine, 500 horse power; one 1,000-horse-power condenser, extensive additions to the steam piping, 125-light arc machine, one 300-kilowatt generator, and one 200-kilowatt generator, and one standard railway switchboard. Additions have been made to the real estate to the extent of one brick building, 41x38, and wooden structure, 33x44. The officers for 1896 are: A. Elliott, president; H. E. Parker, vice president; W. G. Africa, treasurer; J. Brodie Smith, superintendent; J. W. Hildreth, clerk.

CATHODOGRAPHS BY THE DISCHARGE OF LEYDEN JARS AND OTHER DISRUPTIVE DISCHARGES OF STATIC ELECTRICITY.—A NEW METHOD OF PRODUCING ROENTGEN RAYS.

BY

William James Morton, M.D.

The writer, in a recent communication to this journal (Feb. 5) published an article stating that the Röntgen rays—up to that time supposed to require an induction coil and a Crookes tube for their production—were also produced in the open air and in the space intervening between the discharging rods of a static machine. This fact he has since amply confirmed. It is here not so much a question of a brush discharge, as it is

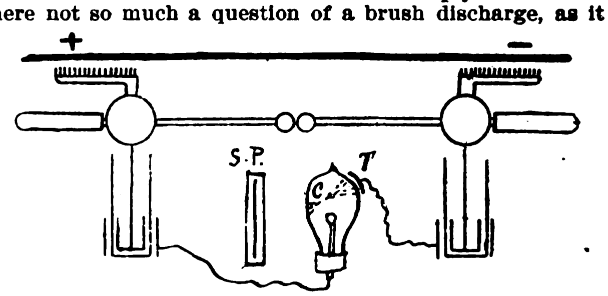


FIG. 1.

of phenomena associated with the disruptive discharge, the projectile cathodic rays, so to speak, existing in space about the disruptive discharge as well as in it. The cathodograph I then showed, although crude, was a true shadow picture, in contradistinction to a familiar effect which may be easily produced upon sensitive plates when metallic objects are placed near to them, or upon them, and are electrified or themselves directly convey electricity in the shape of a fine brush discharge through such sensitive plates. This distinction I made clear in the article referred to.

Having thus primarily recorded the important fact that the

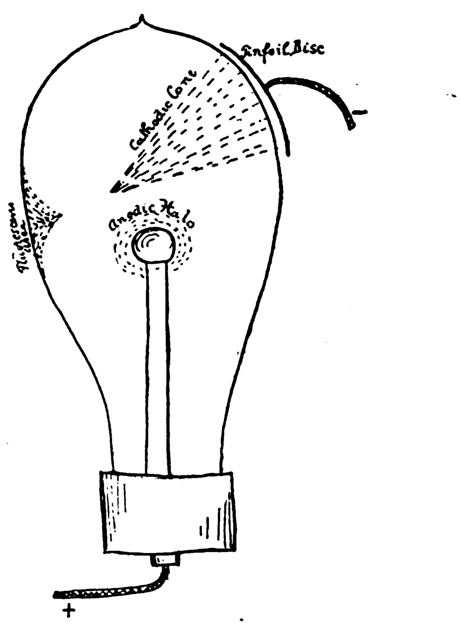


FIG. 2.

Röntgen rays are an associate incident of the disruptive discharge of static machines, and, of course, by analogy, of all other discharges of a similar nature, the pathway to further experimentation was clearly indicated.

Omitting the details of many preliminary experiments, I will come directly to a final and conclusive one, which demonstrates the unquestionable fact that cathodography on a large

and intense scale can be pursued and accomplished simply by the aid of charged Leyden jars alone. The often-quoted and well-authenticated shadowgraphs or pictures produced by the lightning discharge—that mighty disruptive and oscillatory electric current of nature—upon the human body, of objects intervening between it and the discharge, and due, probably, to the interception of these same Röntgen rays by the intervening object, might, indeed, have suggested to us that the disruptive discharge from static machines, and particularly from Leyden jars, would make the repetition of the experiment on a small scale feasible. For just as now in a vacuum tube, when the discharge between the anode and the cathode takes place, the cathodic rays are thrown off with projectile force against the walls of the bulb, so in the statical disruptive discharge, similar projectile radiations may be presumed to exist.

The experiment alluded to above, with Leyden jar oscillatory currents in connection with vacuum tubes, I have now made, fully and from many points of view and with unvarying success. I describe in detail one method of utilizing disruptive discharge currents, which produces the Röntgen rays in a most intense, practical and manageable manner. This method consists in utilizing a current discharge from static machines provided with Leyden jars, or even not so provided, which I described in 1881, and again in an extended paper, with many illustrations, in 1891. This current I termed, in the infancy of thought on this subject, the "static induced current." Its essential feature was the introduction of a spark gap into an otherwise inoperative circuit of the static machine and the excitation of a regulated and periodic flow along a conductor, of an oscillatory discharge of high frequency between the external armatures of Leyden jars. The method of its production may be exemplified by reproducing the connections from the illustrations then published (see Fig. 1). The only change in this cut is to substitute a vacuum bulb in the circuit in place of the ordinary electrodes then shown. Sensitive plates exposed to this vacuum bulb, even at great distances, exhibit all the familiar Röntgen effects, as also do fluorescent substances.

A word may be said as to the nature of the vacuum bulb. Any vacuum bulb may be excited when properly attached to the circuit above described. I happened to have on hand such a vacuum bulb of peculiar construction, described and illustrated, with exactly the same connections as above given in the transactions of the American Institute of Electrical Engineers, of November, 1893, page 604 (see Fig. 2). It is constructed with only one entering terminal, which in this instance is a small ball. This terminal I constitute an anode. Upon the outside of the vacuum tube I fasten a disc of metal, commonly tinfoil, which constitutes a cathode.

The Röntgen rays thus produced are of extraordinary power and intensity. They blacken sensitive films deeply, they penetrate metallic objects, with even too great intensity for near exposure, and the trouble I have found in securing satisfactory pictures is in reducing the time of exposure and lengthening the distance, rather than to the contrary. It is difficult to conceive of the extent to which this new method may be carried when the batteries of Leyden jars filled by powerful Ruhmkorff coils, are brought into play, and it is my belief that in this new method will be found much of the future extension of practical work with the Röntgen rays.

PROF. SCHUSTER ON ROENTGEN'S RAYS.[1]

Professor Röntgen's remarkable discovery will materially affect our views concerning the relation between the ether and matter; but further experimental evidence is required before any opinion can be expressed as to the character of the rays, which behave in so straightforward a manner that they seem to upset all one's notions of the laws of nature. Professor Röntgen, on the strength of his carefully-conducted experiments, has arrived at a conclusion adverse to the idea that the rays only differ from light rays by the smallness of wave-length. Perhaps the following considerations may show that the evidence is not conclusive in this respect:

Röntgen's rays are not cathode rays—there can be no doubt on that point—but they are generated at the point of impact between the cathode ray and solid substances.

The discoverer has not been able to obtain any interference effects, possibly, as he says, owing to the weakness of the radiation. An absence of interference would not, however, be sufficient to show that the radiation is not of the nature of ordinary light, but only that it does not possess sufficient regularity, or, in other words, that the disturbance is not sufficiently homogeneous. That this is the case is not at all improbable, for the radiation is produced by an impact, which in the first instance may be an impulsive motion propagated outwards, and after passing through the screen, would only possess such regularity as is impressed on it by the absorption of the longer waves.

The great argument against the supposition of waves of very small length lies in the absence of refraction; but is this conclusive?

When we speak of the size of the atoms, we mean their distance in the solid and liquid state. The properties of the ether may remain unaltered within the greater part of the sphere of action of a molecule. The number of molecules lying within a wave-length of ordinary light is not greater than the number of motes which lie within a sound-wave, but, as far as I know, the velocity of sound is not materially affected by the presence of dust in the air. Hence there seems nothing impossible in the supposition that light-waves, smaller than those we know of, may traverse solids with the same velocity as a vacuum. We know that absorption bands greatly affect the refractive index in neighboring regions; and as probably the the whole question of refraction resolves itself into one of resonance effects, the rate of propagation of waves of very small lengths does not seem to me to be pre-judged by our present knowledge. If Röntgen's rays contain waves of very small length, the vibrations in the molecule which respond to them would seem to be of a different order of magnitude from those so far known. Possibly we have here the vibration of the electron within the molecule, instead of that of the molecule carrying with it that of the electron.

I should like, further, to express a certain sense of satisfaction that Röntgen's rays are not deflected in a magnetic field. They are thus clearly separated from cathode rays. The idea that cathode rays are due to vibrations has become fashionable; yet the fact that the magnet deflects them just as it would an electrified molecule, has always semed to me to be conclusive against this view. No one has, so far, given any plausible reason why a ray of invisible light should be able to run round in a spiral, while a ray of visible light goes straight; and, so far, Röntgen's rays behave as we should expect well-conducted vibrations to do.

It is not my intention to argue in favor of any particular theory, or against Röntgen's suggestion that we have at last found the formerly missed longitudinal wave. I only desire to put those points forward which at first sight seem to go against the supposition of ordinary light vibrations, and to raise the question whether they constitute an insuperable difficulty.

[1]From "Nature."

ARE ROENTGEN'S RAYS DUE TO CONDENSATIONAL WAVES?—LORD KELVIN'S EARLY VIEWS.[1]

BY J. T. BOTTOMLEY.

In connection with the wonderful discovery by Professor Röntgen of photographic rays, apparently hitherto unknown, and in connection with the speculation which concludes Professor Röntgen's most interesting paper, that these rays may perhaps be longitudinal vibrations of the luminiferous ether, the following extracts will probably be found of interest. They are taken, by permission of Lord Kelvin, from his Baltimore lectures, delivered at the Johns Hopkins University in 1884.

The first extract is from the reprint (now in progress) of Lecture IV. Referring to mathematical work immediately preceding, Lord Kelvin says:

"Suppose that we have at any place in air, or in luminiferous ether (I cannot distinguish now between the two ideas) a body that, through some action we need not describe, but which is conceivable, is alternatively positively and negatively electrified; may it not be that this will give rise to condensational waves? Suppose, for example, that we have two spherical conductors united by a fine wire, and that an alternating electromotive force is produced in that fine wire, for instance, by an alternate current dynamo-electric machine; and suppose that sort of thing goes on away from all other disturbance—at a great distance up in the air, for example. The result of the action of the dynamo-electric machine will be that one conductor will be alternately positively and negatively electrified, and the other conductor negatively and positively electrified. It is perfectly certain, if we turn the machine slowly, that in the air in the neighborhood of the conductors we shall have alternately positively and negatively directed electric force with reversals of, for example, two or three hundred per second of time, with a gradual transition from negative through zero to positive, and so on; and the same thing all through space; and we can tell exactly what the potential and what the electric force is at each instant at any point. Now, does any one believe that, if that revolution were made fast enough, the electro-static law of force, pure and simple, would apply to the air at different distances from each globe? Every one

[1]From "Nature."

believes that if that process be conducted fast enough, several million times, or millions of millions times per second, we should have large deviations from the electro-static law in the distribution of electric force through the air in the neighborhood. It seems absolutely certain that such an action as that going on would give rise to electrical waves. Now, it does seem to me probable that those electrical waves are condensational waves in luminiferous ether; and probably it would be that the propagation of these waves would be enormously faster than the propagation of ordinary light waves.

"I am quite conscious, when speaking of this, of what has been done in the so-called electro-magnetic theory of light. I know the propagation of electric impulse along an insulated wire, surrounded by gutta-percha, which I worked out myself about the year 1854, and in which I found a velocity comparable with the velocity of light. We did not then know the relation between electro-static and electro-magnetic units. If we work that out for the case of air instead of gutta-percha we get simply v (that is, the number of electro-static units in the electro-magnetic unit of quantity) for the velocity of propagation of the impulse. That is a very different case from this very rapidly varying electrification I have ideally put before you, and I have waited in vain to see how we can get any justification of the way of putting the idea of electric and magnetic waves in the so-called electro-magnetic theory of light.

"I may refer to a little article of mine in which I gave a sort of mechanical representation of electric, magnetic, and galvanic forces—galvanic force I called it then, a very badly-chosen name. It is published in the first volume of the reprint of my papers. It is shown in that paper that the static displacement of an elastic solid follows exactly the laws of the electrostatic force, and that rotatory displacement of the medium follows exactly the laws of magnetic force. It seems to me that an incorporation of the theory of the propagation of electric and magnetic disturbances with the wave theory of light is most probably to be arrived at by trying to see clearly the view that I am now indicating. In the wave theory of light, however, we shall simply suppose the resistance to compression of the luminiferous ether, and the velocity of propagation of the condensational wave in it, to be infinite. We shall sometimes use the words 'practically infinite' to guard against supposing these quantities to be absolutely infinite."

The second extract which I give is from p. 143 of the Papyrograph edition of the "Baltimore Lectures"—a portion not yet reprinted.

"The want of indication of any such actions is sufficient to prove that if there are any in nature, they must be exceedingly small. But that there are such waves, I believe, and I believe that the velocity of propagation of electro-static force is the unknown condensational velocity that we are speaking of.

"I say 'believe' here in a somewhat modified manner. I do not mean that I believe this as a matter of religious faith, but rather as a matter of strong scientific probability."

PHOTOGRAPHING AND SEEING IN DARKNESS.

BY

G. d'Infreville

ON Jan. 22 I claimed in "The Electrical Engineer" priority of invention on a process for photographing and seeing in darkness, but, following the advice of friends, I did not disclose the manner of carrying it out in practice.

Some recent articles published in the newspapers and referring more or less to this subject, render it advisable that I should publish what I have been working at for years, as I can easily prove by numerous witnesses, explaining at the same time in a way intelligible to those versed in the art how it can be done.

The process consists of two parts. The first is to cast upon the object to be photographed or seen rays invisible to the human eye, namely, ultra-violet rays. Here I may state that the ultra-violet rays extend about seven times as far beyond the violet as the visible spectrum itself, and I may also say that I incline to believe that the Röntgen rays are far up in the ultra-violet, and for the following reasons:

Swinton has shown that they behave like ultra-violet rays as regards solutions of bisulphide of carbon and of alum. Of greater weight yet is the fact that they fluoresce. Fluorescence is due to rays placed in the spectrum above the color of the fluorescence.

The contrary phenomenon, that of colorescence, has not been so clearly demonstrated.

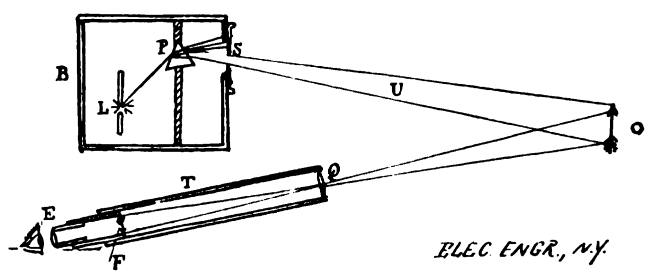
Ultra-violet rays exist in the sunlight and reach the earth's surface when not prevented by the vapor or the dust in the atmosphere. They can also be obtained from the electric arc, whether in free or rarefied air or gases. Magnesium light is very rich in ultra-violet rays, and of late it appears that acetylene gas is remarkable in this respect. The flame of sulphur, especially in oxygen, that of oxide of carbon, and of alcohol, also furnish more or less said rays.

To render the above lights or the objects they illuminate invisible to the naked eye can be obtained by well-known methods. Said rays can be filtered through a solution of iodine between two plates, said plates being such that they allow the ultra-violet rays to pass. As there is, however, no kind of glass known to allow ultra-violet rays to pass freely, I prefer to decompose the light from the source through a quartz prism, to cut off by a proper adjustable shutter all the visible rays and to allow only the ultra-violet rays to pass out and to fall upon the objects which it is desired to photograph or to see, either by reflection or transparency. Gratings are also a well-known means for decomposing the light and obtaining ultra-violet rays.

The second part of my process is to render apparent the objects illuminated as above explained. The objects being thus subject to the invisible light of the ultra-violet rays, I will explain how they can be photographed or seen.

First, how photographed. Referring to the accompanying sketch, I make use of an objective made of quartz or other substance or combination of substances, which allow the passage of the ultra-violet rays while refracting them. The camera itself ought to be plated with glass or lead plates or other material, and of sufficient thickness, so as to protect the sensitive plate from the action of the ultra-violet rays.

A glass frame, coated with some proper fluorescent substance, such as solution of bisulphate of quinine or platino-



D'INFREVILLE'S METHOD OF SEEING IN DARKNESS.

cyanide of barium will take the place of the ordinary ground glass plate used to bring it to correct focus.

The plate chosen ought to be most sensitive to ultra-violet rays, and have been particularly previously shielded by proper wrapping against the action of the ultra-violet rays from any source. It is then put in position and an exposure is made, the time of which can vary from instantaneity to a greater or less period. It can be developed afterwards in a dark room, which must be, like the camera, shielded against the action of any rays from the outside which can affect said plate.

Secondly, as to seeing. I employ for the objective of the telescope or the objectives of the binocular telescopes, a lens, Q, made of quartz or other materials capable of refracting the ultra-violet rays without absorbing them. I receive the image formed inside of the telescope on a plate, F, made of some proper fluorescent substance or, preferably, of thin glass, or other transparent material coated with some fluorescent substance or combination of substances, in order to obtain certain desirable combinations of colors or a greater range of action. A solution of bisulphate of quinine in gum arabic or platinocyanide of barium will also be found suitable here.

The rays which have not been absorbed by the object to be seen pass through the telescope quartz objective, Q, fall upon the plate of fluorescent material, F, where they appear and can be seen from the other side by the ordinary convex ocular glass used in telescopes in case the fluorescent plate is transparent. It can also be observed from the other side by reflection, which is necessary if the fluorescent plate is not transparent.

A quartz prism giving total reflection can also be used in combination with the ocular, the reflecting face of the prism being coated with the fluorescent material. Some luminous paints can also be used if the image is to remain steady. The object can in some cases be seen by transparency instead of by reflection, and some curious effects are obtained. In this case the quartz objective of the telescope can be dispensed with and the fluorescent plate can be enlarged.

I said in my article of Jan. 22 that the process carried with

itself its own remedy. I will now explain. Any object covered with some fluorescent substance, as, for instance, painted with a solution of bisulphate of quinine or uranium glass would indicate immediately by its fluorescence that a light invisible to the eye is being projected upon it.

I wish to conclude by stating that my process has been attested by Mr. T. Commerford Martin, editor of "The Electrical Engineer," and had been communicated to several other persons before a process similar in some respects to mine was published and that I have been experimenting on it to the knowledge of several persons for many years past.

ON RADIANT MATTER.[1]—I.

BY WILLIAM CROOKES, F. R. S.

TO throw light on the title of this lecture I must go back more that 60 years—to 1816. Faraday, then a mere student and ardent experimentalist, was twenty-four years old, and at this early period of his career he delivered a series of lectures on the general properties of matter, and one of them bore the remarkable title, "On Radiant Matter." The great philosopher's notes of this lecture are to be found in Dr. Bence Jones's "Life and Letters of Faraday," and I will here quote a passage in which he first employs the expression radiant matter:

> If we conceive a change as far beyond vaporization as that is above fluidity, and then take into account also the proportional increased extent of alteration as the changes rise, we shall perhaps, if we can form any conception at all, not fall far short of radiant matter; and as in the last conversion many qualities were lost, so here also many more would disappear.

Faraday was evidently engrossed with this far-reaching speculation, for three years later—in 1819—we find him bringing fresh evidence and argument to strengthen his startling hypothesis. His notes are now more extended, and they show that in the intervening three years he had thought much and deeply on this higher form of matter. He first points out that matter may be classed into four states—solid, liquid, gaseous, and radiant—these modifications depending upon differences in their several essential properties. He admits that the existence of radiant matter is as yet unproved, and then proceeds in a series of ingenious analogical arguments, to show the probability of its existence.[2]

If, in the beginning of this century, we had asked, What is a gas? the answer then would have been that it is matter, expanded and rarefied to such an extent as to be impalpable, save when set in violent motion; invisible, incapable of assuming or of being reduced into any definite form like solids, or of forming drops like liquids; always ready to expand where no resistance is offered, and to contract on being subjected to pressure. Sixty years ago such were the chief attributes assigned to gases. Modern research, however, has greatly enlarged and modified our views on the constitution of these elastic fluids. Gases are now considered to be composed of an almost infinite number of small particles or molecules, which are constantly moving in every direction with velocities of all conceivable magnitudes. As these molecules are exceedingly numerous, it follows that no molecule can move far in any direction without coming in contact with some other molecule. But if we exhaust the air or gas contained in a closed vessel, the number of molecules becomes diminished, and the distance through which any one of them can move without coming in contact with another is increased, the length of the mean free path being inversely proportional to the number of molecules present. The further this process is carried the longer becomes the average distance a molecule can travel before entering into collision; or, in other words, the longer its mean free path, the more the physical properties of the gas or air are modified. Thus, at a certain point, the phenomena of the radiometer become possible, and on pushing the rarefaction still further—i. e., decreasing the number of molecules in a given space and lengthening their mean free path—the experimental results are obtainable to which I am now about to call your attention. So distinct are these phenomena from anything which occurs in air or gas at the ordinary tension, that we are led to assume that we are here brought face to face with matter in a fourth state or condition, a condition as far removed from the state of gas as a gas is from a liquid.

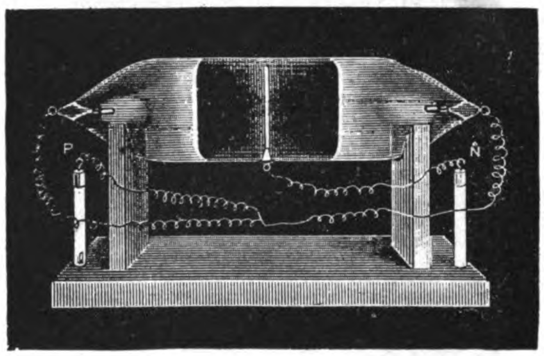


FIG. 1.

MEAN FREE PATH—RADIANT MATTER.—I have long believed that a well-known appearance observed in vacuum-tubes is closely related to the phenomena of the mean free path of the molecules. When the negative pole is examined while the discharge from an induction coil is passing through an exhausted tube, a dark space is seen to surround it. This dark space is found to increase and diminish as the vacuum is varied, in the same way that the mean free path of the molecules lengthens and contracts. As the one is perceived by the mind's eye to get greater, so the other is seen by the bodily eye to increase in size; and, if the vacuum is insufficient to permit much play of the molecules before they enter into collision, the passage of electricity shows that the "dark space" has shrunk to small dimensions. We naturally infer that the dark space is the mean free path of the molecules of the residual gas, an inference confirmed by experiment.

I will endeavor to render this "dark space" visible to all present. Here is a tube (Fig. 1), having a pole in the center in the form of a metal disk, and other poles at each end. The center pole is made negative, and the two end poles connected together are made the positive terminal. The dark space will be in the center. When the exhaustion is not very great, the dark space extends only a little on each side of the negative pole in the center. When the exhaustion is good, as in the tube before you, and I turn on the coil, the dark space is seen to extend for about an inch on each side of the pole.

Here, then, we see the induction-spark actually illuminating the lines of molecular pressure caused by the excitement of the negative pole. The thickness of this dark space is the measure of the mean free path between successive collisions of the molecules of the residual gas. The extra velocity with which the negatively electrified molecules rebound from the excited pole keeps back the more slowly moving molecules which are advancing toward that pole. A conflict occurs at the boundary of the dark space, where the luminous margin bears witness to the energy of the discharge.

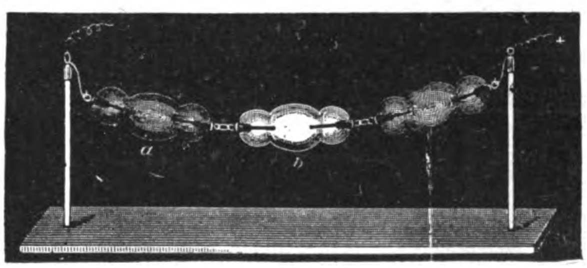


FIG. 2.

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1. A lecture delivered before the British Association for the Advancement of Science, at Sheffield, Friday, August 22, 1879.

2. I may now notice a curious progression in physical properties accompanying changes of form, and which is perhaps sufficient to induce, in the inventive and sanguine philosopher, a considerable degree of belief in the association of the radiant form with the others in the set of changes I have mentioned.

As we ascend from the solid to the fluid and gaseous states, physical properties diminish in number and variety, each state losing some of those which belonged to the preceding state. When solids are converted into fluids, all the varieties of hardness and softness are necessarily lost. Crystalline and other shapes are destroyed. Opacity and color frequently give way to a colorless transparency, and a general mobility of particles is conferred.

Passing onward to the gaseous state, still more of the evident characters of bodies are annihilated. The immense differences in their weight almost disappear; the remains of difference in color that were left are lost. Transparency becomes universal, and they are all elastic. They now form but one set of substances, and the varieties of density, hardness, opacity, color, elasticity, and form, which render the number of solids and fluids almost infinite, are now supplied by a few slight variations in weight, and some unimportant shades of color.

To those, therefore, who admit the radiant form of matter, no difficulty exists in the simplicity of the properties it possesses, but rather an argument in their favor. These persons show you a gradual resignation of properties in the matter we can appreciate as the matter ascends in the scale of forms, and they would be surprised if that effect were to cease at the gaseous state. They point out the greater exertions which Nature makes at each step of the change, and think that, consistently, it ought to be the greatest in the passage from the gaseous to the radiant form.—"Life and Letters of Faraday," vol. 1., p 308.)

Therefore the residual gas—or, as I prefer to call it, the gaseous residue—within the dark space is in an entirely different state to that of the residual gas in vessels at a lower degree of exhaustion. To quote the words of our last year's President, in his address at Dublin:

"In the exhausted column we have a vehicle for electricity not constant like an ordinary conductor, but itself modified by the passage of the discharge, and perhaps subject to laws differing materially from those which it obeys at atmospheric pressure."

In the vessels with the lower degree of exhaustion, the length of the mean free path of the molecules is exceedingly

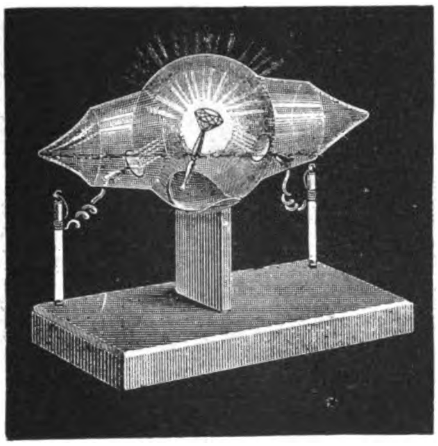

FIG. 3.

small as compared with the dimensions of the bulb, and the properties belonging to the ordinary gaseous state of matter, depending upon constant collisions, can be observed. But in the phenomena now about to be examined, so high is the exhaustion carried that the dark space around the negative pole has widened out till it entirely fills the tube. By great rarefaction the mean free path has become so long that the hits in a given time in comparison to the misses may be disregarded, and the average molecule is now allowed to obey its own motions or laws without interference. The mean free path, in fact, is comparable to the dimensions of the vessel, and we have no longer to deal with a continuous portion of matter, as would be the case were the tubes less highly exhausted, but we must here contemplate the molecules individually. In these highly exhausted vessels the molecules of the gaseous residue are able to dart across the tube with comparatively few collisions, and radiating from the pole with enormous velocity, they assume properties so novel and so characteristic as to entirely justify the application of the term borrowed from Faraday, that of radiant matter.

RADIANT MATTER EXERTS POWERFUL PHOSPHOROGENIC ACTION WHERE IT STRIKES.—I have mentioned that the radiant matter within the dark space excites luminosity where its velocity is arrested by residual gas outside the

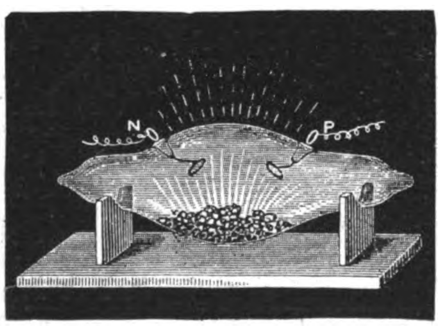

FIG. 4.

dark space. But if no residual gas is left, the molecules will have their velocity arrested by the sides of the glass; and here we come to the first and one of the most noteworthy properties of radiant matter discharged from the negative pole—its power of exciting phosphorescence when it strikes against solid matter. The number of bodies which respond luminously to this molecular bombardment is very great, and the resulting colors are of every variety. Glass, for instance, is highly phosphorescent when exposed to a stream of radiant matter. Here (Fig. 2) are three bulbs composed of different glass: one is uranium glass (a), which phosphoresces of a dark-green color; another is English glass (b), which phosphoresces of a blue color, and the third (c) is soft German glass—of which most of the apparatus before you is made—which phosphoresces of a bright apple-green.

My earlier experiments were almost entirely carried on by the aid of the phosphorescence which glass takes up when it is under the influence of the radiant discharge; but many other substances possess this phosphorescent power in a still higher degree than glass. For instance, here is some of the luminous sulphide of calcium prepared according to M. Ed. Becquerel's description. When the sulphide is exposed to light—even candle light—it phosphoresces for hours with a bluish-white color. It is, however, much more strongly phosphorescent to the molecular discharge in a good vacuum, as you will see when I pass the discharge through this tube.

Other substances besides English, German, and uranium glass, and Becquerel's luminous sulphides, are also phosphorescent. The rare mineral Phenakite (aluminate of glucinum) phosphoresces blue; the mineral Spodumene (a silicate of aluminium and lithium) phosphoresces a rich golden yellow; the emerald gives out a crimson light. But, without exception, the diamond is the most sensitive substance I have yet met for ready and brilliant phosphorescence. Here is a very curious fluorescent diamond, green by daylight, colorless by candle-light. It is mounted in the center of an exhausted bulb (Fig. 3), and the molecular discharge will be directed on it from below upward. On darkening the room you see the diamond shines with as much light as a candle, phosphorescing of a bright green.

Next to the diamond the ruby is one of the most remarkable stones for phosphorescing. In this tube (Fig. 4) is a fine collection of ruby pebbles. As soon as the induction-spark is turned on, you will see these rubies shining with a brilliant rich red tone, as if they were glowing hot. It scarcely matters what color the ruby is, to begin with. In this tube of natural rubies there are stones of all colors—the deep-red and also the pale pink ruby. There are some so pale as to be almost colorless, and some of the highly prized tint of pigeon's blood; but under the same impact of radiant matter they all phosphoresce with about the same color.

Now the ruby is nothing but crystallized alumina with a little coloring matter. In a paper by Ed. Becquerel,[*] published twenty years ago, he describes the appearance of alumina as glowing with a rich red color in the phosphoroscope Here is some precipitated alumina prepared in the most careful manner. It has been heated to whiteness, and you see it also glows under the molecular discharge with the same rich red color.

THE WEEK'S PROGRESS IN SHADOW PHOTOGRAPHY.

SINCE our last issue appeared numerous experimenters have obtained results of more or less interest in shadow photography, both with and without the use of the X-rays emanating from vacuum tubes properly excited, while others have put forth novel ideas as to the utilization of the phenomena made available.

During the week Mr. Edison has continued his experiments and we reproduce in Fig. 1 a cathodograph print illustrating the permeability of thirty substances, numbered as follows, all being as nearly as practicable 1-32 inch thick: (1) iron; (2) brass; (3) lead; (4) tin; (5) antimony; (6) bismuth; (7) cadmium; (8) platinum; (9) copper; (10) aluminum; (11) soft rubber; (12) hard rubber; (13) celluloid; (14) slate; (15) ivory; (16) gelatine; (17) shellac; (18) boric acid; (19) paper; (20) vulcanized fiber; (21) gutta-percha; (22) rosin; (23) stearic acid; (24) asphalt: (25) phonograph cylinder composition; (26) amber; (27) camphor; (28) albumen; (29) glacial phosphoric acid, shellaced; (30) coin silver.

In order to determine whether the rays could be reflected Mr. Edison placed a vacuum bulb in front of the large end of an iron funnel, eight inches long, the small end of which, ¾ inch in diameter, was placed close to the photographic plate. After exposure and development there appeared on the plate two overlapping circular images of the small end of the funnel. Similar experiments with a funnel 9 feet long showed no results, but a general fogging of the plate.

Having in mind the well-known fact that sunlight is fatal to many forms of bacterial disease germs, Mr. Edison proposes to subject various germ cultures to the action of the X-rays.

Since the first announcement of the discovery of Professor Röntgen many photographs have been taken of objects at rest. The fact that baricyanide of platinum phosphoresces in the dark by the action of the X-rays, and also that the light may be seen on both sides of the phosphorescent screen, sug-

[*] "Annales de Chimie et de Physique," third series, vol. lvii., p. 50, 1859.

gested to him that an object would cast its shadow, and thereby form a luminous picture upon paper, prepared with that material. Other experimenters have been reported very recently to have performed similar experiments, among them Professor Salvioni, of Perugia, Italy, of whose experiments we gave a brief account in our last issue. According to a later cable dispatch, Professor Salvioni's apparatus consists of a cylinder of cardboard, the inner surface of which is coated with a material that becomes fluorescent under the action of the Röntgen rays. The lens is at one end of the cylinder. The object to be examined with its coverings is placed between a Crookes tube and the cylinder; on looking into the tube through the lens the observer sees the outline or shadow of the concealed object, which is thrown on the fluorescent interior. The device is still crude, but the inventor expects soon to perfect it. He calls it the cryptoscope.

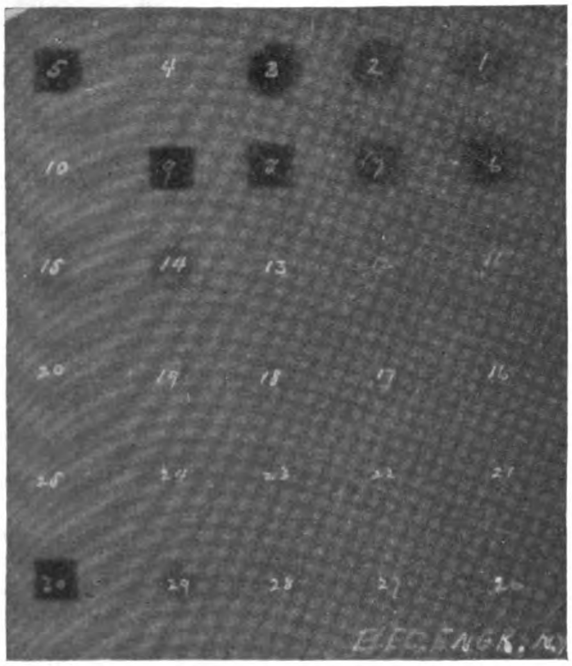

FIG. 1.—CATHODOGRAPH OF 30 DIFFERENT SUBSTANCES.

Mr. E. P. Thompson, of New York, has put forward a scheme for observing shadowy pictures of objects in motion. The details of the proposed apparatus for carrying out the experiment comprises the following elements:

An opaque tube open at one end for the eye to look into and provided with a fluorescing screen at the other, formed by covering a thin piece of white paper with barium platino-cyanide. The object of using white paper or else paper of the same color as the luminous fluorescence is that in addition to the light radiated there may be reflected fluorescent light from the paper itself, the source of light being the film of fluorescent material.

In examining small motions, as, for example, those of the living skeleton of a spider, and in case of a very powerful generator of X-rays giving sufficient light to spare for purposes of refraction, the tube should contain a fluorescent light.

To test this instrument, which may be called a kinetoskotoscope, one looks into the eye aperture, being careful to hold the eye close to exclude all light, and places the object whose motion is to be studied between the other end of the tube and a Crookes tube, all as close together as possible. For small experiments, one looks at the luminous shadow picture, for instance, of a paper-cutter in the process of passing between the leaves of a pamphlet, or the moving wheels of a watch in an aluminum cover.

Professor McGie, of Princeton, is said to be at work on a similar apparatus. Professor Röntgen, in his paper, printed in our last issue, states that the X-rays are not reflected. It is reported, however, that Professors McLellan and Wright, of Toronto University, have succeeded in reflecting and focusing the rays by means of a glass bell jar covering the vacuum tube, and that instantaneous cathodographs can be taken by these focused rays.

LETTERS TO THE EDITOR.

SENSATIONALISM IN THE DAILY PRESS.

Dr. Schuyler S. Wheeler has favored us with a copy of a letter addressed to the New York "Herald," which we print below as originally worded:

"I notice with regret the rush of sensational articles in the daily press in connection with the new cathodography. It is a great pity that much misleading matter is laid before the general public mixed with some that is of profound value and the confusion, loss of respect, etc., which must follow must result in injustice to the profession.

"The articles which have heretofore appeared in the "Herald" upon the subject have been clear, of intense interest and great scientific value, but a day or two ago I saw one of a different character on restoration of life, and to-day a large illustrated article on brain photography, which is not only void of professional dignity and lacking in taste, but bears unmistakable signs perfectly apparent to the serious reader of its real nature. As for the accompanying illustrations of "his own brain," how is it that if the picture is obtained by rays passing through the head the picture is one showing a few surface veins and marks upon the surface of the brain, such as are used to illustrate elementary text books.

"We have and always shall have to suffer a great deal through the public being misled in technical matters by the press, and it would be of inestimable value if you would take the stand of allowing no matter of this kind to appear except after close scrutiny, and let it be known that what appears in the 'Herald' upon such scientific topics has been passed upon and is unquestionable. I believe the New York 'Herald' is most likely to be conservative, and I have therefore taken the occasion to call this to your attention."

ARE THE X-RAYS IDENTICAL WITH DRAPER'S "TITHONIC RAYS"?

I should like to call the attention of those who are investigating the Röntgen rays to the remarkable papers of Dr. J. W. Draper on the so-called "Tithonic Rays," a "class of chemical rays analogous to the rays of dark heat," to which he found writing paper and quartz "far more permeable than the purest plate glass."

Dr. Draper's experiments were made between 1841 and 1844, and will be found in the appendix to his somewhat scarce "Treatise on the Forces Which Produce the Organization of Plants," New York, pp. 144 et seq. (copy can be consulted at my office). They are exceedingly suggestive, especially where he points out that a large number of bodies "obstruct the radiation" of the tithonic rays, so that apparently shadows will remain on a sensitive plate if it be covered by any substance which, while permitting passage to direct rays, will (like glass to radiant heat) obstruct the rays radiated back from the plate. Note also the article on Roric Figures, in Appleton's Cyclopaedia.

PARK BENJAMIN.

New York, Feb. 14, 1896.

MARKS A STEP IN THE RIGHT DIRECTION.

Your account of the work of the New York Edison Company is admirable. It will be a source of much useful information to those engaged in electric lighting business. An electric journal should not confine its pages to things that are new or have the appearance of being new. Old and well-established things which represent the features of the best practice are more important. I, for my part, prefer to read an account of a first-class electric light station than to puzzle over such sensational stuff as seeing without light, light without heat, etheric lighting, wabbling the charge of the earth, etc. I think that "The Electrical Engineer's" issue of Jan. 8 marks a step in the right direction in electrico-technical journalism.

M. I. PUPIN,

Department Electrical Engineering, Columbia College, New York.

THOROUGH AND FULL OF DETAILS.

I really wish to congratulate you upon the recent issues of the "Engineer."

Your description of the Edison stations in New York City was thorough and full of those details that interest practical engineers. I read it quite slowly and carefully and, though I am familiar with Edison station methods, I found many things in that article that were new. Mr. Mavor's series of articles on Concentric Wiring were full of interest and your Patent Office articles by Mr. Dodge are well worth reading.

A. E. DOBBS.

Brooklyn, N. Y.

THE

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[INCORPORATED.]

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CONTENTS.

SHADOW PHOTOGRAPHY.

ONE would have thought that all possibilities in the production of cathodographs, or, speaking more broadly, shadow photographs, had been exhausted, but each succeeding day brings forth new ideas or conceits, some of evident promise, but not a few of more than doubtful character. Touching for the present upon the former, the work of more recent experimenters appears to be largely concentrated on methods of obtaining these curious effects by means other than the rays emanating from vacuum tubes. We have already chronicled some important results obtained in this line of research, and to these we add this week another contribution by Mr. J. H. Robertson, who has succeeded in securing a shadow photograph by means of the arc light, pure and simple. Leaving out of consideration the theory put forward by Mr. Robertson to account for the phenomenon, it may be fairly assumed that the fact is established that some of the rays emanating from the arc light penetrate opaque substances and are capable of affecting a sensitized photographic plate. Indeed, a recent experiment is recorded in which a similar effect was obtained with ordinary sunlight after extended exposure. At the first blush such a proposition might be negatived by pointing out, as Professor Elihu Thomson did in a recent issue of "The Electrical Engineer," that if direct sunlight affected photographic plates it would be impossible to keep them unfogged. But, on the other hand, there is corroborative evidence to be found in the vagaries which photographers not infrequently encounter upon developing plates, and which have never been satisfactorily explained. Apropos of this aspect of the question is the interesting letter by Dr. Park Benjamin, which appears on another page, in which that erudite writer points out the similarity in some respects of the X-rays, and the "tithonic" rays of Dr. Draper, studied by him as far back as 1844.

One of the most interesting of the side paths opened up by Röntgen's discovery is the possibility it holds out for observing objects in the dark. Several experimenters have already begun work on this branch, which also seems to have been anticipated in a remarkable way by Mr. Georges d'Infreville, who, it will be remembered, in a recent issue of "The Electrical Engineer" stated in general terms the manner in which such a scheme could be carried out. The recent publication of similar ideas by others has now relieved Mr. d'Infreville of the necessity of maintaining silence on his methods, which he now fully describes on another page. The project itself is entirely correct in theory and has already been shown to be feasible in practice. Just to what extent the process can be utilized in the arts and sciences remains to be seen; but that it is of unquestioned value must be apparent.

Thus far the application of shadow photography seems to have been confined almost exclusively to surgery and medicine; but we are glad to know that an attempt has been made to employ the process at the Carnegie steel works for the purpose of examining iron structures, and, though the first results obtained, we understand, were not encouraging, it is to be hoped they will be continued. It has also been suggested that the process might be employed for the purpose of discovering bad work, such as imperfect joints in electric wiring. We do not imagine that the taking of cathodographs after the work is finished will take the place of the watchful eye of the foreman or insurance inspector, but that the cathodographic process may be applied to the examination of a variety of electrical

work seems quite probable. In view of the relationship which exists between the X-rays and the radiant matter of Professor Crookes, we have thought that our readers might desire an authentic statement on the latter, and have therefore reproduced Professor Crookes' lecture of 1879.

While the zeal with which this whole subject has been taken up by electricians and physicists in general is most commendable, we cannot refrain from expressing our regrets at the manner in which the discovery and its applications have been treated in the daily press. It is well within the province of the latter to keep the public informed of the latest progress in science as well as of the developments in the latest murder case, but unfortunately not a few of our daily contemporaries have allowed the imaginations of their reporters to run riot, with the consequence that much of the good effect which the discovery might have produced in elevating science in the public mind has been destroyed and given place to doubts and to incredulous shakings of the head. That we are not alone in thus deploring this state of affairs is manifested by the letter addressed by Dr. S. S. Wheeler to one of our daily contemporaries, which we reproduce in another column. Perhaps, however, we may be too severe on the daily press, and it may be barely possible that the workers in this new field may themselves be responsible to some extent for some of the hare-brained schemes to which the new discovery has been alleged to be applicable. There is enough that is good and valuable in the discovery, however, to make it outlive any temporary set-back which it may have received at the hands of the lay press; and when the popular excitement has died down we may hope to hear of the beginning of real progress in the study and application of the X-rays.

THE ZURN BILL BEFORE THE NEW YORK LEGISLATURE.

IT has become one of the favorite pastimes for the average legislator to pose as the champion of the people in the curtailing of the powers of companies operating under municipal franchises. The latest instance of this kind is to be found in the Zurn bill, now before the New York legislature, the object of which is to reduce the price of electric lighting in New York and Brooklyn. This bill, which was before the Assembly Committee on Electricity, Gas and Water Supply, contains the following clause:

It shall not be lawful for any company or companies organized to supply electric lights in cities of this state having a population of 800,000 or over to charge more than three-fourths of a cent per light per hour for each incandescent light, nor more than 4 cents per hour per light for each arc light.

According to Mr. Zurn, in New York City gas sells for $1.25 per 1,000 feet, giving with a five-foot burner 200 lights of sixteen candle power. The same amount of light by incandescent electric lights would cost $2.40. The question, therefore was reduced to cost of production, and it remained for electric light companies to show they could not produce the same amount of light from a ton of coal as could the gas companies and produce the same as cheaply. If they were not doing so it did not follow they could not do so, for it was a well-known fact that many electric lighting companies were confined to the use of devices which were not the best in the market nor the most economical in their operation. The public, argues Mr. Zurn, should not be compelled to shoulder the expense of bad management, faulty engineering, or any of the sins of omission or commission of the companies or the persons who manipulate them; it was obviously no more than just that the electric lighting companies, as light dispensers and sellers, should be governed by the same law which holds with other light producers and dispensers, and, as light could be measured as readily as any other article of merchandise, it followed that it might be rated at a certain value, whether produced by gas or electricity. There were means for determining the amount of light given at any specified point, and, as with heat, the price depended upon the two factors, time and quantity. Let the electric light people face the issue of cost of production, and face the conclusions which must be the logical outcome of their position!

The logic of Mr. Zurn's arguments is little short of ludicrous, and the bill itself would be scarcely worthy of serious consideration were the measure itself not being actively pushed in the State Legislature. To argue that the same amount of electric light ought to be produceable from a ton of coal as can be got from gas with the same amount of fuel is sufficient to show the absolute worthlessness of the facts offered in substantiation of the Zurn bill. But conceding even some of the contentions of Mr. Zurn, the fact remains that the large consumers in New York City are to-day paying no more for electric lighting than they would for an equivalent amount of lighting by gas. That the small consumer has not yet been placed on the same advantageous level is certainly not the fault of the electric lighting companies, who have steadily reduced their prices and who have always been willing, to our knowledge, to give their customers the benefit of all the improvements which have been made in the art. It seems little short of barbarism to put the pioneer companies who have spent hundreds of thousands of dollars in developing a new art to the expense of discarding all their old apparatus the instant an improvement in detail makes its appearance. Yet even on this alleged dereliction on the part of the companies, Mr. Zurn seems to be lamentably misinformed. Any one who has followed the history of the electric lighting companies in New York and Brooklyn must know that they have kept in the vanguard of progress in all that relates to the cheap generation and distribution of current; and it is due to this very fact that they have been able to produce and distribute current at the prices at which they are doing at the present time. Perhaps if Mr. Zurn had had a chance to read the recent description of the Edison stations in New York City which appeared in one of our January numbers, and contemplated the enormous investment of capital required to reach the perfection everywhere exhibited, the bill bearing his name might not have seen daylight. What makes the bill still more absurd on its face is its limitation to cities above 800,000 inhabitants. The merest tyro in central station finance could have shown that in just these very cities the cost of generation and distribution of electric current in which conductors are, by law, compelled to be carried underground, and in which all manner of restrictions are placed upon the companies by the local authorities, far exceeds that met with in smaller towns, so that, if for no other reason, a reduction of income would be a particular hardship on the companies located in such cities. Up to our going to press no action had been taken on the bill, and it is to be hoped that none will be. While affecting, it is true, only the cities of New York and Brooklyn, the principle involved is a broad one and ought to have the earnest attention of the New York State Electric Lighting Association.

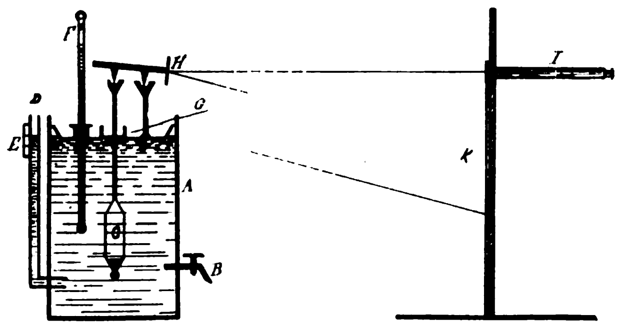
MISCELLANEOUS.

A SUGGESTION FOR SHOWING MINUTE CHANGES IN THE DENSITY OF LIQUIDS.

BY NEVIL MONROE HOPKINS.

WITH the apparatus shown in the accompanying sketch some interesting determinations in the specific gravity of liquids can be made. A is a tin reservoir with a cock, B, for bringing the fluids to be determined to constant level, which may be shown by the scale E on the gauge.

The float G consists of a circular pan or dish of metal with a tube opening for a thermometer (F) and a hydrometer (C). The stem of the hydrometer should be of very small diameter for delicate work, as it rises and falls through greater distance for a given change in density than a coarse stem. The top of the hydrometer stem carries the little bearing which supports one end of the aluminum beam, carrying the little mir-



A SENSITIVE HYDROMETER METHOD.

ror (H), the other end of the beam being supported by the standard on the float. The little beam with its knife edges keeps the hydrometer in the centre of the opening in the float and prevents any error which would be caused by the friction of contact. A stand and scale with the telescope (I) attached completes the apparatus.

The change in densities of liquids due to temperature changes can readily be observed and solutions of salts accurately compared. To use the galvanometer expression, the readings are nearly "dead beat." It will be readily seen that a hydrometer of this delicacy is limited to only the smallest changes. Could such a mirror device be connected with a storage battery, when at work, the behavior and changes in specific gravity of the acid could be closely observed.

PRESSURE AND CONDUCTIVITY.

An article by Gustav Tammann in "Zeit. Physikal. Chem." is summarized in the Journal of the Chemical Society: The influence of pressure on conductivity may be divided into three factors; (1) volume alteration; (2) alteration of viscosity and ion friction; (3) alteration of the degree of dissociation. The effect of pressure on viscosity has been determined by Cohen for sodium chloride solutions; the viscosity of solutions of small internal pressure diminishes with increase of pressure, the reverse obtaining with solutions of high internal pressure. The effect on the dissociation constant is given in a table of percentage alteration due to pressure of 500 atmospheres for solutions of varying concentration and dissociation. The total effect is then considered and typical curves are given. With infinite dilution, factors 1 and 2 alone are weighty, and these cause an increase of about 4.5 per cent. (for 500 atmos.). If the concentration increases, there are three types of curves: (I) where the electrolyte is feebly dissociated, the curve rises to a maximum and slowly falls; (II) where the dissociation is great and factor 3 of small account, the curve is at first almost parallel to the axis of concentration, then slowly sinks, owing to the effect of the viscosity, and finally cuts the axis; (III) for intermediate dissociation, the rise is not as rapid as in (I), and a well-marked maximum occurs. The curve is also given in the case of sulphuric acid, which is shortly considered; a maximum occurs here at concentration 0.5 per cent. and a minimum at 85 per cent.

ELECTRIC HEATING—I.

BY W. S. HADAWAY, JR. NEW YORK.

THE term "electric heating" is commonly used to express the frittering down of the high potential energy of electricity into the lower potential energy of heat. There is no well defined line of demarcation; the resultant is inseparable from the conveyance or utilization of electricity in any degree. The term is therefore a meaningless one from the heat engineer's standpoint, and it fails to accurately express the performance of useful work by the transmission of heat energy to a distance by means of electricity. The expression "electricity as a factor in a telethermal system" would be a better definition of the subject-matter of this paper, but for obvious reasons the shorter and simpler term is employed.

We are to regard heat energy as a commodity that can be generated or controlled in convenient form and distributed and sold, and in which electricity is used either directly as the high potential heat factor or indirectly as agent. The distribution and application of heat energy by electricity to arc and incandescent lighting, to metal welding and forging, and in the Cowles and Acheson furnaces are illustrations of results already attained in electric heating, and are properly discussed under the broad interpretation of our subject. The feature of the subject that we are to consider here is the practical adaptability of commercial electricity for heating purposes and for performing useful work under the conditions imposed in general industrial and domestic life, outside of the specific adaptations previously mentioned, and particularly in connection with other heat distributors for a multi-potential heat supply.

These applications may be roughly divided into two classes, according to the degree of concentration of the heat energy used, the first including low temperature heating, generally diffused and in large volume, and the second including high temperature heating, generally localized and in small quantity. In heating on a small scale no adequate classification is possible; it is the shading of high potential heat energy into low potential heat work for many useful operations that primarily suggests the feasibility of heat transmission by electricity. The arbitrary line of temperature demarcation for heating on a large scale is here drawn at 250 degrees F. The closest common analogy to the differences between low potential large volume and high potential small volume heating is the distinction between volume and pitch in sound. As examples of the first class may be cited the heating of rooms and of water under atmospheric pressure; examples of the second class, are oven, sad iron, and soldering iron heating.

The electrical horse power hour is the equivalent of 2544.6 British thermal units. For practical purposes the work in hand is to determine the useful work in different lines obtainable from this number of heat units at a fair average cost of supply; it involves, indirectly, determinations of relative efficiency between electric and common methods of heat generation, distribution, and application.

To show what the heating efficiency of different methods of application may mean, the following experiments, reviewed in the London "Electrician" for November 2, 1894, are cited: the determinations were the relative heating value of combustion and electricity by resistance. The same wires were heated first in a flame and then by electric current. It was found that with a platinum wire held in the flame less than 0.5 per cent. of the thermal energy produced in the flame was transferred to the wire, while 90 per cent. of the electrical energy used appeared as heat.

In another case an iron bar weighing about 20 pounds was heated by charcoal and then by electricity; in the former case about 0.75 per cent. of the thermal energy was transferred to the bar and in the latter case 88 per cent. It is evident from the description that the calorimetric methods employed were rough, and the results are quoted more as qualitative than quantitative determinations. It should be observed that the foregoing illustrations are examples of our second class of heating. Figures obtained from tests made on energy required to heat one gallon of water by various methods of heat application show that there are wide differences in efficiency in our first class of heating. The heat capacity of the work performed was sufficiently large to express the relative differences in impartivity, and as we should expect, the lower the temperature of the work the larger the area heated, and the greater the capacity the less the difference in ratio between heating

1 Abstract of paper read before the Am. Society of Heating and Ventilation.

by combustion and by electricity, and we can easily determine the conditions when the ratio is an inverse one.

In room heating apparatus on continuous run we may figure that one watt, 3.4 thermal units, will heat one square foot of common radiator surface through 1.35 degrees F., and that 100 watts, or 340 thermal units, will heat the surface approximately 135 degrees F. above the room temperature. That is, for room heating, 100 watts are practically the equivalent of steam at low pressure condensed by one square foot of radiator surface with the difference between the room and the radiator temperatures as above stated. This, of course, takes no account of the heat capacity of the apparatus, which is practically eliminated by the condition imposed of continuous running.

We may safely assume that a fair average price of the horse power hour from large steam electric stations is five cents. It would therefore cost 0.67 cent to run one square foot of direct radiator surface for one hour, or the electrical horse power would keep about 7.5 square feet of radiator surface at the temperature differences noted for one hour. For direct comparison with a central station low potential heat distributor, we may compare this cost with figures of charges made by the New York Steam Company as quoted by Unwin in his treatise on "The Development and Transmission of Power." The unit of heat used by the New York Steam Company is stated to be the "kal," which is defined as the heat required to evaporate one pound of water from 100 degrees F. into steam at 316 degrees F. or at 70 pounds pressure per square inch. One kal is therefore about 1,110 thermal units. On a sliding scale the charge is stated to be 70 cents per 1,000 kals to small customers and 40 cents per 1,000 to large users. As the price of five cents per horse power hour is to a large user we will compare it with the 40 cents per 1,000 kal rate. For 40 cents the consumer secures 1,110,000 thermal units from the steam station compared with 20,518 thermal units from the electric station, a ratio of nearly 54 to 1, or practically 50 to 1, as a loss must be figured in the case of steam, dependent upon the temperature at which the condensed water is allowed to escape.

It is interesting to note in passing that while the relative generative efficiencies are about as eleven to one, the commercial rates are as fifty to one. The ratio of the cost of heat energy from the electric station to the cost from the steam station is therefore practically four times as great as the ratio of the relative costs of production. This fact should be borne in mind in discussing Crompton's paper on Electric Energy, in which the influence and importance of the "load factor" is pointed out.

Clearly the steam electric light station ranks low as a heat distributor for house warming on a large scale. Notwithstanding the great disparities in the cost of heat energy on a large scale, the uses to which small electric air heaters are put are surprisingly numerous. We are all more or less familiar with the use of gas stoves for room warming; it is found by experience that the electric air heater for auxiliary room warming, for bath and dressing rooms, for libraries, cabins on yachts and steamships, in mild climates, in early morning and evening, etc., serves its purpose economically and effectively. It is then, on a comparatively small scale and in intermittent service that the electric air heater is useful when power is derived from the steam electric station and when the heat supplied is derived from electric resistance.

While considering the use of electricity in diffused heating on a large scale, we should not overlook the deductions made by Lord Kelvin "On the Economy of the Heating or Cooling of Buildings by Means of Currents of Air" and published in the Glasgow Philosophical Proceedings, Vol. III, December, 1852, and followed by mathematical demonstrations in the Cambridge and Dublin Mathematical Journal for November, 1853. Quoting from these articles:

"In the mathematical investigation, it is shown that according to the general principles of the dynamical theory of heat, any substance may be heated 30 degrees above the atmospheric temperature by means of a properly contrived machine driven by an agent spending not more than about 1-35 of the energy of the heat thus communicated; and that a corresponding machine, or the same machine worked backwards, may be employed to produce cooling effects, requiring about the same expenditure of energy in working it to cool the same substance through a similar range of temperature. When a body is heated by such means about 34-35 of the heat is drawn from surrounding objects and 1-35 is created by the action of the agent; and when a body is cooled by the corresponding process the whole heat abstracted from it, together with a quantity created by the agent, equal to about 1-35 of this amount, is given out to the surrounding objects."

We have thus introduced refrigeration as well as heating by electricity as agent. In editing his Mathematical and Physical Papers, Lord Kelvin added the following interesting note under the date of June 26, 1881:

"The method of cooling air in unlimited quantities described in this article has been realized by Mr. Coleman, first in refrigerators used for the distillation of paraffine, and after that in the Bell-Coleman refrigerator for carrying supplies of fresh meat from North America to Europe, in a great refrigerator recently sent out for the abattoir at Brisbane, Queensland. The Bell-Coleman machine sends large quantities of air, cooled to 10 to 20 degrees C. below the freezing point, into the chamber to be kept cool, and the general temperature of this chamber is thus maintained at the desired point.

"The method of heating air described in the article remains unrealized to this day. When Niagara is set to work for the benefit of North America, through electric conductors, it will, no doubt, be largely employed for the warming of houses over a considerable part of Canada and the United States. But it is probable that it will also have application, though less large in other cold countries, to multiply the heat of coal and other fuels, and to utilize wind and water power (with aid of electric accumulators) for warming houses."

In Anderson's treatise on the Conversion of Heat into Work, third edition, pp. 189 and 194, will be found descriptions of compressed air refrigerating machines made on the principle above described, and in Prof. Peabody's work on the Thermodynamics of the Steam Engine, pp. 464 and 465, will be found tests on a Bell-Coleman refrigerating machine. The use of electric motors in refrigeration has already received consideration of central station men, having been advocated by well-known engineering authorities, but so far as I can learn nothing whatever has been accomplished in the use of motors for heating purposes.

When electricity is derived from water power we might expect a far wider availability of energy from heat of resistance for house warming than when electricity is derived from steam power. Careful deductions show that the cost of the horse power year must not exceed $6 in order to compete directly with good coal at $5 per ton for house warming in this latitude. The statistics of Prof. Swain show that the average cost of the mechanical horse power year from water power in this country is about $10; to this we must add electrical generation and transmission charges, making it seemingly impossible to realize a figure for electrical energy delivered that will not be three or four times the cost of heat directly from coal. In the Niagara power transmission scheme, I understand it is contemplated selling the electrical horse power year for $20. At this rate it may well be questioned whether there are not sufficient compensating advantages in regulation and control to warrant the very extensive use of the heat of resistance for house warming at least, and we are aided in this direction by requiring a lesser maximum capacity of the apparatus, as the heaters may be run night and day without additional cost within restricted areas. There are water power plants in the West where, with large falls, the cost of the horse power year is very low. In these places there will undoubtedly be many expensive applications of room heating on a successful basis.

In his paper on "The Cost of Steam Power," Trans. Am. Soc. of Electrical Engineers, March, 1893, Mr. C. E. Emery cites the cost at Lawrence, where, with moderate fall, the cost of the horse power year from water power is figured at about $25, or practically the same as power generated from steam. We thus see that in the practical treatment of this question local conditions will control the breadth of applicability, including in these local conditions prime cost of electric power, cost of coal delivered, extremes of climate, average humidity, etc.

We have still another source of electrical energy to consider in connection with low temperature diffused heating in which power is derived from gas, oil, and air engines. Prof. Kennedy, in a lecture before the Royal Institution in April, 1893, on the "Utilization of Energy," places the theoretical efficiency of coal gas at 80 per cent. Of this a gas engine, he says, utilizes from 22 to 32 per cent. For diffused heating it is apparently more economical to distribute the gas than to attempt to convert it into kinetic energy and transmit it by electricity. In this connection I would call attention to Mr. Williams' paper before the Society of Arts, Boston, May 10, 1894, in which comparative costs of coal and various fuel gases are given, and in which it is shown that the gas equivalent of coal may, under most favorable circumstances, cost eight or ten times as much as coal.

The consideration of the relative values of gas and electricity for heating purposes is a matter which can only be inadequately discussed here, for the problem is a complicated one and demands the most thorough consideration. No one can underrate the facility of storage of gas, the economy of rapid and continuous generation, available heat from combustion, and discharge of by-products, whereas in electric lighting and electric heating every unit of light or heat secured represents an appreciable loss or depreciation of the energy converter. There are many advantages to be considered on the other side, such

as localization, immersion of heater in working chamber, as in ovens, sad-irons, and water heaters, freedom from by-products, etc. In electric heating for domestic use, as in the use of gas for the same purpose, the bête noir of the situation is how to provide the hot water supply economically. It seems easier to arrange for this on a multi-potential heat supply system than on any system using gas, unless the heat wasted in gas manufacture can be stored and utilized.

In his treatise on Gas Engines, Donkin shows examples of gas engines of considerable size, furnishing power at rates less than can be secured from other prime movers. A case has come to my attention of a gasoline engine supplying energy at the dynamo terminals at a cost slightly under one cent per horse power hour. For high potential heat distribution from isolated plants this form of energy transmitter is generally available; but it may be seriously questioned whether, in isolated plants for domestic use, the hot water supply as commonly provided can be economically heated.

We may safely conclude from the foregoing illustrations that we cannot afford to use high potential kinetic energy for general diffused heating purposes on a large scale. The thermal unit is the equivalent of 778 foot pounds of work, and we would secure as much heat by applying a brake directly to the fly-wheel of the engine or prime mover as we obtain from the heat of electrical resistance which, so far as its results go, may be considered as friction. One pound of good coal has a potential heat energy as great as 5 7-10 horse power hours.

If we use as an average thermal value of the pound of coal 14,500 units, we can secure 9,400 units in a good boiler, or practically 65 per cent. There are many cases in practice in which this efficiency is exceeded, but Thurston's figures give 65 per cent. as a fair average value. The fuel efficiency of the steam engine rarely exceeds ten per cent., and the heat incapable of conversion into high potential energy represents about nine-tenths of the whole, notwithstanding the fact that over six-tenths of the thermal energy of the coal is secured in useful work in the boiler.

It is therefore to this point we must look for our large volume heat supply, and we find in actual practice many illustrations which show that no great engineering difficulties are encountered in distributing the boiler energy, and also that of the exhaust steam from the engine, for useful work at a distance.

The New York Steam Company's plants already referred to are distributing energy by live steam for heating and power purposes at about 80 pounds pressure, the pressure differing, however, in the uptown and down-town stations. The leakage and radiation losses are stated to be estimated at about 15 per cent., yet with this loss the heat energy can be delivered on a very economical and successful basis.

The work of Birdsill Holly since 1877 in carrying out central station heat supply is too well known to require comment. It is important and interesting in connection with our problem, since it shows that central station diffused heat supply is entirely feasible. We are now able to formulate a multi-potential heat supply system in which the steam, either live or exhaust or both, is used for low temperature work, and electricity from generators in the same station is employed for all work requiring temperatures in excess of that of the steam; i. e., from about 250 degrees F. upwards.

In domestic work the steam heat would be employed for house heating and water heating for bathing and culinary purposes. Electric heat would be used for lamps, ovens, broilers, small portable stoves, sad-irons, curling irons, and all purposes requiring a high temperature localized heat. And a feature of such a combination not to be overlooked is the facility with which ventilation and heat regulation can be secured, since all the elements are at command to force an abundant supply of heated pure air through the building to be warmed.

There are no new or untried features in such a combination; practically all the elements necessary for the work are already employed, though in a somewhat disjointed form as far as complete flexibility of heat supply from one center of distribution is concerned. In the "Electrical Engineer" for April 5, 1893, will be found a description of the Springfield (Ill.) electric light and steam distribution plant. In operating this plant the exhaust steam is used for warming buildings, but so far as I am aware no systematic attempt has been made to carry out a multi-potential heat supply. The revenue from building heating, I am informed, was over $12,000 during 1894, which is largely clear gain, considering it from the standpoint of the common electric light station, barring of course the fixed charges for the extra equipment. An instance occurred in Boston of a small, centrally located electric light station paying its expenses by the sale of steam for heating purposes.

CONTEMPORARY ELECTRICAL SCIENCE.

"Wiedemann's Annalen" for January contains many somewhat startling contributions. Electric waves are, as usual, the staple product of German-speaking physicists, although Boltzmann and Planck deliver two separate attacks upon modern "energetics," chiefly as expounded by Ostwald. It seems that the mechanical theory of the universe and scientific materialism, so ably attacked by the great chemist, will not surrender without a struggle. Planck himself also writes upon the reasonance of electric waves, and shows how the distribution of energy in a resonating circuit may be calculated from Maxwell's equations. Elster and Geitel contradict the rumor that positive electricity is dissipated, like negative, by the action of light. They show that it is all due to a secondary action upon the platinum cathode as soon as it gets coated with a layer of vapor from the liquid sodium-potassium alloy forming the anode. V. von Lang has an interesting little paper upon "The Diminution of Resistance of a Light Contact Between Carbons or Metallic Terminals" under the action of the slight electric waves produced by an electric gas lighter or by an electrophorus. The experiment with carbon is easy, but that with metals requires great care in order to avoid the slightest concussion. Leo Arons discusses the curious fact that "Alternate-Current Arcs" are much more difficult to produce with metallic than with carbon electrodes, and suggests three possible explanations. The carbon may be better suited to sustain the necessary heat through the zero points, owing to its smaller thermal conductivity. Or the gases which carbon always will evolve up to its own death, in spite of all precautions, may undertake this function. Or the metallic oxides are in the way. Perhaps further experiments will bring more light.—London "Electrician."

SOME HINTS TO INVESTIGATORS OF SPARK SPECTRA.

At the present time, when attention is keenly directed to the subject of spark spectra, it may be desirable, for such as are interested, to study a recent paper by A. de Gramont on the direct spectrum analysis of minerals and fused salts (vide "Comptes Rendus," cxxi., pp. 121-123). Many of the minerals have sufficient conductivity or volatility to permit the passage of a condensed electric spark between the small fragments of the mineral attached to the pole of the coil. With a condensed spark the spectrum shows the lines both of the metals and of the non-metals present in the mineral; without the condenser, the spectra of the non-metals disappear, and those of the metals show only the brightest lines. Certain fused salts behave in a similar way, and when the condensed spark is used, the spectrum contains the lines of all the elements present, together with some air lines, which, however, are much enfeebled, especially if the striking distance is short. Without the condenser, the spectra are complex, and characteristic of each particular salt. De Gramont suggests that such spectra are probably produced by undissociated molecules.

THE ELECTRICAL CONDUCTIVITY OF ALUMINUM.

In an article appearing in the London "Electrical Review," Mr. G. L. Addenbrooke announces that, according to researches of Lord Kelvin, the conductivity of pure aluminum is 68.5 per cent. of that of pure copper. The usual conductivity, as given in the books, hitherto has been 56 per cent. that of copper. Lord Kelvin's research has, therefore, raised this by 21 per cent., so that the conductivity of a wire of pure aluminum of the same section instead of being a little over a half that of a copper wire of similar section, is more than two-thirds the conductivity. Consequently, the diameter of an aluminum wire of the same conductivity as a given copper wire will be only 15 per cent. greater, or less than one-sixth greater than that of the copper wire. This is a small fraction, and it is evident that for such a small increase of diameter the extra cost of insulating aluminum conductors to the same thickness as copper ones, and to secure the same conductivity, will present no serious obstacle.

Looked at in another light, copper is about 3.3 times the weight of aluminum; on Lord Kelvin's figures the conductivity of wire of equal weights of copper and aluminum will therefore be as 100 : 22.6, so that the weight of an aluminum wire of the same conductivity as a copper one would be four-ninths of the latter, or considerably less than one-half.

It would be difficult to say what extra cost would be entailed in manufacturing aluminum of this purity, but it may be assumed that before long the resources of metallurgy will be equal to it at a moderate cost.

As aluminum is just as pliable and easy to work as copper, it goes without saying what an advantage it would be in constructing heavy cables, and how much less strain on the insulating material it would impose. For overhead conductors for the supply of power the advantages of obtaining a conductor of equal conductivity with a trifling increase in diameter and of half the weight are also manifest.

As a conductor aluminum is now about twice as costly as copper, but as by the electrolytic process the price has already been reduced in eight years from 90 cents per ounce to 35 cents per pound, it is abundantly clear that with the inevitable improvements which are taking place the difference in price between aluminum and copper, which still exists, will be more than obliterated before long.

THE CENTRAL STATION INDUSTRY IN FRANCE.

In a recent issue "L'Industrie Electrique" publishes the sixth edition of its provincial central station table. In January, 1895, France, exclusive of Paris, possessed 328 electric supply stations; to-day the total is 438. The increase in the total horse-power has not, however, been very great; the figures for the 378 stations which sent in returns showing a total of 47,712 h. p. (126 h. p. per station), as against 39,420 for the 328 stations at work last January. The 378 stations may be classified as follows:

Motive Power—	No. of Stations.	H. P.
Hydraulic	182	11,665
Hydraulic and steam	48	7,422
Steam	128	26,802
Producer gas	6	206
Town gas	13	1,605
Petroleum	1	12
	372	47,712

System—	No. of Stations.	H. P.
Continuous	293	31,935
Alternate	75	14,927
Polyphase	4	850
	372	47,712

"LITTELL'S LIVING AGE."

The January issues of "Littell's Living Age" contain many papers of more than usual interest and value. Among others may be mentioned "Lord Salisbury," by Augustin Dilon; "Mathew Arnold in His Letters," by Alfred Austin; "Kashmir," by Sir Lepel Griffin; "The Air Car, or Man-lifting Kite," by Lieut. B. Baden Powell; "Corea and the Siberian Railway;" "Muscat," by Theodore Bent; "In the Wild West of China," by Alicia Bewicke Little. "1920," from the "Contemporary Review," is a thoughtful forecast of the future growth and importance in the world of the Anglican race, and furnishes much food for thought. Other articles worthy of prominent notice are "The Peasant Life of South Russia," from Blackwood; "Purcell and the Making of Musical England," by Frederick J. Crowest; "William Blake," by Alfred T. Story; "Fighting Thurlow, His Foes and Friends," by W. P. Courtney; "The Lost Ambassador," by Margaret Howitt; "Recollections of Thomas Carlyle," with many others of scarcely less value. Fiction is well represented by short stories from the pens of M. B. Hardie, John Habberton, I. Hooper, etc. A page of the best current poetry accompanies each number The above partial table of contents of one month's issues bears witness to the fact that the recent reduction in price from $8 to $6 does not mean any lowering of the value, or any falling off from the high standard this magazine has hitherto maintained. The busy men and women of today, who demand the best that the literary field can supply, will find "The Living Age" as fresh, timely, and indispensable as ever. Littell & Co., Boston, are the publishers.

SOME FACTS ABOUT ACETYLENE GAS.[1]

BY JOHN C. MC MYNN, M. E.

ACETYLENE gas has been known for many years as a laboratory product too expensive for anything but experimental use. A possible method of producing this gas on a commercial basis was developed in the electric furnaces of the Wilson Aluminum Company, at Spray, North Carolina, by Mr. T. L. Wilson while experimenting with the production of aluminum and the smelting of other very refractory substances, such as lime, silica, calcium, etc., under the direction of Major J. T. Morehead, the President of the Company and a geologist of reputation. Experiments were being conducted with a view of combining the metal calcium with other metals, and in the course of such experiments lime and coke were fused together and the resulting product thrown into water, when it produced a violent bubbling by giving off a gas which, when lighted, gave an intensely brilliant flame. A long series of experiments followed, made by Dr. De Clalenot and Major Morehead, to determine the correct proportions of lime and coke, together with the analysis of all mixtures and resulting products.

In a recent visit to Spray, North Carolina, I found a very primitive electric furnace, the current for which is furnished by two 120 K. W. alternators. The voltage is transformed down to about 100; the carbons are twelve inches by eight inches, and 36 inches long, and with between 1,300 and 1,400 amperes the brilliancy and intense heat produced can hardly be imagined unless seen. Finely powdered coke and crushed lime are thrown between the carbons and fused in the intense heat, which results in the production of calcium carbide. This is a black crystalline substance, very hard and insensible to heat, but when placed in water produces a carbon vapor, through the chemical combination of two parts of carbon with two parts of hydrogen, and which possesses the highest illuminating power of any known gas. The calcium combines with the oxygen of the water, thus making a double decomposition.

A company has formed to develop its production and to sell rights for its manufacture. The new product has been the target for all the usual criticisms, and such papers as the New York Tribune and the Engineering and Mining Journal in recent issues have asserted that there was never a ton produced in this country, and if there were it would have cost over $100 per ton. These statements can only be excused through a biased determination to oppose any new process, or a disinclination to investigate both sides of a question. That the new gas will be a rival to electricity cannot be denied, and as owners and managers of electric lighting plants it behooves the members of this association to invesugate the subject for themselves and to decide as to its value as an opponent to not only the incandescent, but the arc light, and not to take the advice of such electrical papers as are too cowardly to state the truth, or too lazy to investigate. While at Spray every facility was given me to fully examine the plant and to make measurements of all factors entering into its manufacture. I regret that at this time I cannot make my report public, but I can state most emphatically that while I was there two tons of calcium carbide was produced in two days and at a cost of about $25 per ton. Samples of this carbide produced an average of 5.13 cubic feet of acetylene gas per pound of carbide. The methods used at Spray can be improved upon by any one building a new plant and many of the losses eliminated.

In regard to its use as an illuminant, acetylene gas when burned in a tip using one cubic foot per hour will produce about 50 candle power, but the flame, which is a solid flame, having no blue portion near the burner, seems to diffuse much more than this amount of light, because of the fact that its spectrum is nearly identical with that of the sun. A one-half cubic foot tip will give a flame that is ample for all purposes of house lighting, and these tips will be most generally used. Admitting that these tips will replace the common 4 or 5 cubic foot tips, we would have one-half cubic foot, giving more light than 4 cubic feet of common gas. Or 1,000 cubic feet of acetylene giving more light than 8,000 cubic feet of ordinary gas.

The average price for gas in the six plants in Southern Wisconsin is $1.76 per 1,000 cubic feet; hence the corresponding price for acetylene gas would be $14.08 per 1,000 cubic feet. That is, acetylene gas could give the same amount of light per 1,000 cubic feet for this price. But the fact is that this gas can be produced at any suitable electric plant in Southern Wisconsin for a miximum figure of $5 per 1,000 cubic feet.

The gas can be used in several ways.

First.—Distribution through mains is not the most advisable method since leakage would be a large factor and the original investment large.

Second.—The carbide can be distributed to residences and a small automatic generator placed in the basement, in which a week's supply could be stored. A house having 20 burners would probably use 10 burners for about 4 hours per day, and with one-half cubic foot tips would consume 140 cubic feet of gas per week, or about 28 pounds of calcium carbide, at a cost of 3 cents per pound. This would give a gas bill of $3.36 per month, and the house would be much more brilliantly lighted than it could be in any other way except by a larger number of incandescent lights.

Third.—A valuable property of the gas is that it will liquefy

1. A paper read before the Northwestern Electrical Association, at Milwaukee, Jan. 17 19.

itself if the resulting gas is contained when water is added. This liquid gas is to be distributed in cylinders similar to carbonic acid gas cylinders (as used for soda water fountains), and when admitted to the house mains through pressure-reducing valves, it assumes all its gaseous qualities. I am at present investigating the liquefaction process and will publish the results of my experiments.

To sum up the situation from an electrical standpoint: This is a new gas having an illuminating power much greater than common gas. No investment for street mains is necessary, hence the gas companies must use it either as an enricher or as an adjunct to their present system to supply isolated buildings and residences, which can be reached neither by their present mains nor by electric lights. If they obtain the rights for this gas, they will have a weapon which will be as much stronger than the Welsbach burners, as the acetylene flame is stronger than the Welsbach light. To produce this gas or calcium carbide, the gas companies must put in electric plants, which when not in use making carbide, can be placed in competition in electric lighting.

There are places and many of them where nothing will ever supersede the use of electric lights, but when you consider that only 5 per cent. of the residents of Southern Wisconsin are reached by gas and only 30 per cent. are reached in Milwaukee, and that even less can be supplied with electric light, there is a field opened which is wonderful in the possibilities for successful investments and large business.

Most of your lighting plants are idle during at least half the time, and could thus be made producing plants for the whole time, and you could reach a territory which cannot be reached by either the gas companies or yourselves without large outlays for extensions, and, in most cases, not reached at all.

Of the following facts I am certain: 1. The gas is intensely brilliant. 2. It has a decidedly disagreeable odor if it escapes without being burned, and when burned emits no odor or smoke. 3. The gas can be distributed for much less cost (considering the interest on the investment) in cities, and also to every resident of the State, whether in the city or country. 4. The same amount of light can be produced for much less cost than by ordinary gas or electricity, for one-third cubic foot of acetylene gas burned per hour gives more illumination than a 16-candle power incandescent light, or 5 cubic feet of ordinary gas. Allowing a maximum cost of $50 per ton for carbide, delivered either as a liquid or as carbide—

16 C. P. with acetylene (⅓ cubic feet per hour) costs $.0016
16 C. P. incandescent costs practically.............. .006
16 C. P. ordinary gas at $1.76 per 1,000 cubic feet with 4 feet tip................................ .00704

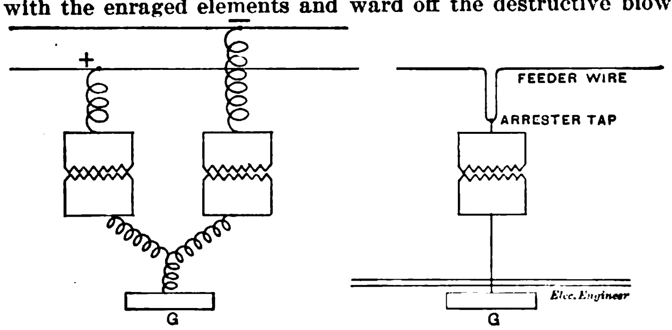
or acetylene costs 16-100 of a cent per hour as compared with electricity at 6-10 of a cent and ordinary gas at 7-10 cent.

The above figures are based on the present method of manufacture and maximum cost, and no allowances are made for the improvements which must necessarily follow experimentation by practical men.

LIGHTNING ARRESTERS.[1]

BY W. R. GARTON.

One of the most trying questions presented to the workers in the electrical industry has been the development of a reliable and accurate lightning arrester, which would effectually cope with the enraged elements and ward off the destructive blow



FIGS. 1 AND 2.

commonly known as the static discharge. To this end many have striven, resulting, not only in numerous developments, but the outcome in many instances has been a most happy solution.

The variety of design is almost as great as there have been ideas to promulgate and carry into effect. But no matter how efficient the device or how perfectly it performs its functions, it is useless unless installed in reasonable numbers, in well chosen places. It is very often considered a trick of the manufacturer in prescribing a goodly number of arresters, but both theory and practice have conclusively proved that during the existence of the static influences, there are established nodal or non-discharging points where a discharge will hardly ever or never occur. These nodal points are constantly shifting, and therefore it is impossible to locate them, and the only possible way of avoiding them is to provide enough places of outlet, that some of them may be at the discharge point.

It is always advisable to place an arrester at the terminal of each line and especially if it is a long one, as it will almost wholly overcome an effect known as the "kick," which is very trying on insulation. When arresters are placed at the ends of lines, it is found that very heavy end or brush discharges take place. The most feasible explanation of the kick which I have been able to formulate is that similar to the jarring of a water pipe after the pressure has been released and suddenly thrown on again by the closing of the faucet. To overcome this concussion a small neck or extension of the pipe is

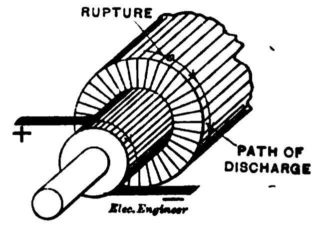


FIG. 3.

made beyond the hydrant. Thus when the strain comes the water is forced to this little end or neck which forms an air cushion and divides the force and neutralizes the shock; the same effect results upon a line, and the end arrester has the effect of overcoming this sudden jar or kick.

The pride of the lineman ofttimes prompts him to inaugurate certain ideas which are most detrimental, such as, for instance, the addition of a few sightly turns or curls in the lead-in or lead-out wires; this alone in many instances is sufficient to completely counteract the good influences exerted by the arrester. I remember having seen this very idea so nicely carried out as to have rendered the lightning arresters of little or no value. (See Fig. 1.) In this particular instance the arresters were in a station connected to an arc circuit. I at once caught sight of these curls of wire leading to and from the arresters. Upon inquiry it was found that they were originally so placed. I also learned that the arresters had always proven very ineffective. I advised their removal and the straightening and shortening of the wires. I learned afterward that this had been done, resulting most satisfactorily. The execution of proper joints or proper contact in the joints is an essential which, quite often, is sadly neglected.

It has always been my custom when puting arresters on a line to insert as much hindrance in the pathway of the discharge, between the apparatus and the arrester, as possible. I almost invariably place the arrester tap in the extreme point of a very abrupt angle or kink in the feeder wire, thus aiding the arrester to turn the lightning to earth. (See Fig. 2). I have found some of these seemingly small things to give admirable results, even though in some instances the so-called arresters were not models.

It is well established that inductive resistance is the most formidable enemy of high frequency currents. Convolutions, turns or curls in a conductor, although few in number, offer more impedance to a discharge than do thousands of feet of straight wire. From this very fact it is obvious how burn-outs in apparatus occur. And it is plain how a small amount of inductive resistance is capable of debarring the static discharge where ohmic resistance cannot withstand. Thus we arrive at the cause for the discharge puncturing the insulation in preference to traversing the path of the normal current.

In the case of the burning out of an armature or field the windings offer a high inductive resistance. The lightning entering at one of the terminals must find a way of escape. (See Fig. 3.) Almost invariably this is through the insulation, or, if an armature, ofttimes from one commutator bar to the next, to an immediate point of outlet. The difference of potential between the point at which the discharge punctures the insulation and the point of leaving the apparatus, due to the resistance of the circuit, which, in the case of an armature, would be counter electromotive force and the field ohmic resistance; would tend to establish an arc maintained by the normal flow. The arc which has followed the lightning over the newly established course, is that which plays havoc. The overcoming of this by the use of a lightning arrester con-

1. Abstract of a Paper read before the Chicago Electrical Association Feb. 7th.

clusively proves that such a device if efficient is invaluable for the preservation and perfect operation of apparatus thus exposed.

The fundamental principle of all lightning arresters is that of discharge points in conjunction with some high resistance between the two sides of the circuit and earth. This is in most instances an air gap. As far as the efficiency of the old original type of air gap, the same as that in use to-day on telephone and telegraph circuits, is concerned, as a lightning arrester, it is most capable. The reason why the simple air gap will not answer, on other than telegraph and telephone circuits is, as has been described, namely, the formation of an arc. The lightning arrester to meet the requirements of railway and electric light circuits must therefore be possessed, not only with the capabilities of an arrester, but also those of a circuit breaker or arc defier.

Lightning arresters are divided into two general classes, viz., those for direct and for alternating currents. Some manufacturers add still another type, that for high tension direct current or arc circuit arrester. The first plan, however, is more predominant. Direct current arresters vary very little from the alternating, in general design, all being constructed upon the same general principles, with perhaps one or two exceptions—such as, for instance, the Wurts types, which vary quite materially in general make-up and form. Those of the Thomson, although of different types, are all constructed upon one fundamental principle, that of the magnetic blow-out.

The direct current arrester is constructed for various voltages ranging from 50 to 5,000 volts, as well as for various current flows, but happily high tension circuits are not circuits of high ampere ranges. The alternating arrester most generally has to do with circuits of small ampere capacity, but high tension, therefore requiring a different mechanism from that of the direct current arrester. But the difference in tension and ampere capacity of the circuit do not always have to do with the different modes of dealing with the two different currents, but the nature of the current to be dealt with more generally controls.

TELEPHONY AND TELEGRAPHY.

FIRE HAZARD FROM TELEPHONE WIRES.

The Boston Manufacturers' Mutual Fire Insurance Company has just issued a number of circulars relating to fire protection, among which we notice the following, covering the hazard from telephone wires:

"Professor Puffer has made special tests with the latest protectors of the American Bell and New England Telephone companies, which are designed to guard against the dangers of crossing of telephone wires by wires carrying currents of great capacities, at pressures varying from 500 to 2,000 volts. In all cases there was a report and a flash of fire when the protector operated. It seemed that if the protector was covered with fine lint, or near a light curtain or the most positions where likely to be used, there would be little or no danger from the flash of the fuse. The protectors are much alike in design, that of the New England Telephone Company being rather the better. Though some improvements are still desired in both protectors, they are in their present shape so good that their immediate use is advised and believed necessary for safety on all telephone wires.

"When we come to the great class of private wires for bells, watch clocks, telephones not the property of the American Bell Telephone Company, but often running out of doors where subject to contacts with high-voltage wires, it is easy to find the greatest risk of fire, because there is usually no attempt to make use of protectors of any kind. There being no demand for such a thing, there seems to be but very little offered by the trade.

"The best remedy is to so run these wires wherever possible that they could not fall on, or be fallen upon, by foreign wires of any kind. It may be noted that any foreign wire may be dangerous, though nominally carrying a harmless current, as it may itself be in contact with a high-voltage wire. When wires cannot be completely isolated, protecting devices equal to those of the telephone companies are necessary for safety, and should be used as soon as something satisfactory can be developed."

SOUTHERN NEW ENGLAND TELEPHONE CO.

The annual meeting of the Southern New England Telephone Company was held at Providence, R. I., on Jan. 28, President M. F. Tyler, presiding. Mr. Tyler in his address said that the reduction made in rates six months ago had borne good fruit in the way of new business, and that the outlook for the future was very bright. He said that reports from all parts of the State showed satisfaction with the service rendered.

The following figures are from the President's statement: Gross earnings, $503,715.55; operating expenses, $348,069.77; net earnings, $155,645.78; fixed charges, $43,742.58; net earnings above all expenses, $111,903.20; paid in dividends, $86,250, or 5¾ per cent.; spent in construction of new plant, $231,000; increase in number of subscribers during year, 1,296, with five new exchanges.

Directors were elected as follows: M. F. Tyler, J. W. Alling, Joseph English, S. E. Herwin, A. H. Robertson and W. E. Downes, of New Haven; A. O. Morgan, of Boston; Thomas Sherwin, of Boston; Lyman B. Jewell, of Hartford.

OBJECTING TO THE NEW CABLE CODE.

At the last meeting of the New York Chamber of Commerce Mr. Thurber reported a preamble and resolution that, whereas the official vocabulary prepared under the direction of the International Telegraphic Conference had been adopted for use in telegraphic messages throughout Europe, from Jan. 1, 1898, and, whereas the vocabulary was inadequate and faulty, it was resolved that the Chamber protested against the use of this vocabulary and directed the Secretary to make known this protest to the cable companies having offices in this city, and desired its members to use their influence to secure the abrogation or revision and extension of the vocabulary. This matter has already been treated fully in the columns of "The Electrical Engineer."

EDUCATIONAL.

INSTITUTE FOR HOME STUDY OF ENGINEERING.

WE have received from the "Scientific Machinist" of Cleveland a copy of the handsome descriptive catalogue of its Institute for the Home Study of Engineering, carried on in that city. The work of the Institute is confined to Electrical and Mechanical Engineering, and this is done very carefully by a system which has proved a great success by the correspondence method. It has not only prepared and printed a comprehensive course specially adapted to this method of instruction, but has designed at great expense an equipment of practical apparatus, which the student can procure at moderate cost, and use at his own home in connection with his study. The staff of the Institute is able to give a course of great merit and commercial value to every one ambitious to learn and to qualify himself for the great work of the present and future. The course is under the direction of Mr. Nelson W. Perry, whose wide engineering training and previous experience in tuition have unusual value for such important work. With him are associated Messrs. N. S. Amstutz and J. C. Lincoln.

The school has also on its staff Arthur R. Curtis, M. E., professor of mechanical drawing in the Colorado State School of Mines; Mr. H. F. Cook, M. E., and others.

The officers of the Scientific Machinist Company are: F. D. Leslie, president; J. H. Norton, treasurer, and G. A. Robertson, secretary. This company publishes the "Scientific Machinist," founded in 1881. Its circular matter is creditable in form and style.

THE ELECTRICAL ENGINEERING COURSE IN THE SCHOOL OF MINES, COLUMBIA COLLEGE.

The 1895-96 programme of the Columbia College course in electrical engineering has been received. The officers of the electrical engineering department are Dr. Francis B. Crocker, Professor, and George Francis Sever, Instructor. Professor Pupin and Mr. Freedman, of the Department of Mechanics, devote nearly all their time to instruction in the theoretical branches of electrical engineering. The regular four-years' course leading to the degree of Electrical Engineer (E. E.) is designed for the education of professional electrical engineers who intend to devote their lives to the practice of this profession, either as teachers in colleges and scientific schools or as engineers, managers, or experts in manufacturing or other industrial enterprises.

The course of instruction includes not only all branches of theoretical and applied electricity, but also the other collateral sciences which have been found by experience to be required by the electrical engineer, such as mathematics, physics, chemistry, drawing, analytical mechanics, mechanical engineering, including a thorough course in steam and other engines, as well as transmission machinery; general engineering, including construction in masonry, iron, steel, and wood, also forms part of the course.

Hence the graduate in the course in electrical engineering is provided not only with a thorough knowledge of the principles and practice of electricity, but also with such a broad and liberal education in the allied sciences as will prepare him for every demand that is likely to be made upon him in after life in connection with his profession, and will also enable him to become an investigator.

The instruction is by lecture, recitation, laboratory and drawing-room practice, with periodical examinations.

Special attention is given to new methods and forms of apparatus in order that the student may be brought fully abreast of the rapid progress of electrical science and practice.

Frequent visits are made to the numerous electrical factories, stations, and other establishments in and about New York.

THE LEHIGH UNIVERSITY, South Bethlehem, Pa., has just issued a pamphlet relating to the work of its School of Mechanical Engineering, which is under the direction of Professor J. F. Klein. The brochure is full of interesting data and is accompanied by a schedule of the mechanical engineering course.

SOCIETY AND CLUB NOTES.

MASSACHUSETTS ELECTRICAL ENGINEERS AND MECHANICS' ASSOCIATION.

The following is a list of the officers of this association for the ensuing year: Past president, Joseph L. Winn, with the Bryant Electric Company, Cambridge; president, John A. Collicott; superintendent inspection department, Messrs. Frank Ridlon & Co.; vice president, Chas. A. Fuller, with the Boston Electric Company; financial secretary, Lewis T. Hoffman, inspector Edison Illuminating Campany; recording secretary, Geo. V. Rowe, Boston Electric Company; treasurer, Chas. H. Toner, electrician Herald building; chaplain, James L. Gethins, with the Boston Fire Alarm Company; conductor, James M. Costello, electrician; assistant conductor, E. B, Fairchilds, electrician; librarian, Chas. Johnson, with Edison Illuminating Company; inside guide, Geo. E. Kerby, electrician; trustees, James E. Cole, chief inspector wires, Boston; E. O. Lundin, superintendent lamp department, Boston Electric Company, and Chas. Clark, electrician.

This association was organized April, 1890, is in a flourishing condition, and has about eighty members. The association meets every 2d and 4th Monday nights at 3 Boylston Place, Landmark Hall. The sixth annual ball of this association was held in Copley Hall on the evening of Feb. 10, and easily excelled all balls of the season in electrical displays. The hall was decorated with bunting, flags and foliage and with electrical displays and designs in incandescent lamps, of which over 1,800 were used.

Mr. John A. Collicott, president, and Mr. James Winn, chairman of the committee on arrangements, did all in their power to surpass all the previous balls. Many prominent electrical men were present.

THE HENRY ELECTRICAL CLUB.

On January 24 Dr. Louis H. Laudy delivered a lecture on "Electric Meters" before the Henry Electrical Club. He introduced the subject by illustrations from the gas meter and pointed out the advantage the electric meter possessed in the ease with which a fraction of the total amount could be measured.

Electric meters might be divided into the following classes: Electrolytic, thermal, differential time meters, motor meters, and photographic, or continuous record meters. The desirable features in a good meter were many, and no one yet introduced could be said to possess them all. Among these features were accuracy, small consumption of energy, simplicity and durability, and constant rate of error under all conditions of temperature.

Dr. Laudy described and showed in operation the leading styles of meters, together with some laboratory instruments which he said were far too delicate and expensive for commercial use. He told of the trying conditions under which meters were often placed, and said that while many had been invented very few had attained commercial success.

At a meeting of the Henry Electrical Club, held on Feb. 7, Mr. Joseph Sachs delivered a lecture on "Electric Heating and Its Applications."

To within a few years ago, the lecturer said, the well-known effect of an electric current heating the conductor through which it passed had not been commercially utilized. Electric heating had been regarded only as an undesirable bye-product.

Now, however, the principle had been applied to a variety of uses, and it was possible to employ electricity in many domestic operations.

Cooking with electrically heated utensils was yet too expensive to be generally adopted, but in many cases it possessed advantages over direct heating.

The heat was applied just where it was required; it was under perfect control, and there was the greatest cleanliness.

But it was in its application to the arts that electric heating had shown its greatest development. In the electric furnace the intense heat of the electric arc was employed with great success in reducing refractory materials, and in the production of chemical compounds. Carborundum and calcium carbide were now produced in large quantities, solely as a result of the introduction of the electric furnace.

In welding, the electric process was superior to direct heating, as it developed heat at the welding points only.

Mr. Sachs made a large number of successful experiments, illustrating every point in his lecture.

MINNEAPOLIS ELECTRO-TECHNIC CLUB.

"The Electro-Technic Club" has been formed in Minneapolis. Its membership will be restricted to electrical engineers, or those engaged in allied work, and its territory will include the whole Northwest. The headquarters of the club are located at Room 23, Syndicate Block. The following are the officers and charter members: President, Charles L. Pillsbury; first vice president, Edward P. Burch; second vice president, Charles H. Chalmers; secretary, W. E. Stephenson; treasurer, George A. Lintner.

Professor George D. Shepardson, Edwin B. Burch, Charles H. Chalmers, George A. Lintner, E. A. Scofield, W. W. Dakin, Frank W. Springer, C. L. Pillsbury, V. I. Gray, W. I. Gray, A. H. Savage, W. E. Stephenson, Frank Reidhead, F. E. Chapman and Harry Lackore constitute the membership.

THE ELECTRIC LIGHT ASSOCIATION OF PENNSYLVANIA.

At the last meeting of the Executive Committee of this association, held in Philadelphia, Mr. John R. Wheeler was elected Secretary to succeed Mr. C. A. Woole, resigned. All communications intended for him should be addressed to 403 Grant street, Pittsburg, Pa.

The Secretary will, before the next annual meeting of the Association, visit the various companies in the state, with the view of effecting a more compact and vigorous organization of the electric light interests, the need of which, it is believed, is apparent to all concerned.

The annual meeting of the association has been postponed to Wednesday, April 1, 1896, at 2 o'clock, p. m., to be held at the Commonwealth Hotel Harrisburg, Pa.

FINANCIAL.

SALE OF THE PHILADELPHIA EDISON CO.

The terms for the purchase of the Philadelphia Edison Company by the Pennsylvania Heat, Light and Power Company were practically agreed upon at a meeting of representatives of the two corporations last week. Several matters still require adjustment, but the understanding is that everything will be settled within a few days or a week. The terms of the Edison Co. were accepted, and the 20,000 shares of stock in that company will be taken at $150 by the Pennsylvania Company.

President Charles M. Swain, of the Edison Company, is quoted as follows: "The negotiations are still pending. The Pennsylvania Heat people accepted our ultimatum of $150 a share for our stock and agreed to pay $50 in cash and $100 in trust certificates, or bonds, secured by a deposit of the stock. There are a great many matters of detail to perfect, and there are still two or three points on which we have been unable to come together. Until those are agreed upon we cannot say that the transaction has been perfected. We will meet again, probably in a few days or a week, but what the result will be I, of course, cannot say."

The consummation of the purchase on the part of the Pennsylvania Heat, Light and Power Company will require the expenditure of an even $1,000,000 for the $50 on the 20,000 shares. For that purpose it will be necessary to call for another assessment on the stock. The first call netted $1,000,000, but, as certain expenditures have been made, there is probably not more than $800,000 in the company's treasury at this time. A call for $5 a share, netting $250,000, would therefore be sufficient, but that would leave no money in the treasury for extending and operating the system. It is probable that, while making the call, it will be made for $10 a share, which would give the company a good working capital of nearly $300,000 after paying for the Edison stock.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS, ISSUED FEB. 11, 1896.

Alarms and Signals:—

ELECTRICAL BURGLAR ALARM. C. Coleman, Chicago, Ill., 554,505. Filed Nov. 20, 1895.

In a burglar alarm, the combination with a signaling device and a meter adapted to control it, of an electrical circuit, including said meter, and extending from the office to the guarded structure, and permutating rheostats arranged in said circuit and located at distant points.

Galvanic Batteries:—

BATTERY. W. S. Doe, Brooklyn, N. Y., 554,247. Filed Sept. 18, 1895.

Consists of a closed vessel forming an extension of the porous cup to form a receiver for the gas emanating from the depolarizing fluid and a reservoir for the latter.

VOLTAIC BATTERY. S. R. V. Robinson, Brooklyn, N. Y., 554,427. Filed May 9, 1894.

Designed for reducing the local action in the battery.

Conductors, Conduits and Insulators:—

ELECTRIC CABLE. T. Guilleaume, Mulheim-on-Rhine, Germany, 554,263. Filed March 19, 1895.

An electric cable comprising a main conductor and a safety conductor, so that upon the safety conductor breaking, the current is diverted from the main conductor, before the latter breaks.

INSULATING JOINT. G. J. Carson, Chicago, Ill., 554,332. Filed Sept. 23, 1895.

Consists in certain peculiarities of the construction.

INSULATING JOINT. L. McCarthy, Boston, Mass., 554,394. Filed Oct. 14, 1895.

Consists in applying a suitable quantity of dry powder insulating substance, at the places where air spaces are likely to be formed in the completed article, and subsequently rendering such substance plastic and solid by the application of heat.

CONDUIT FOR ELECTRIC CONDUCTORS. F. Fuller and J. M. Kinney, Boston, Mass., 554,631. Filed May 24, 1895.

Consists of a sheet of metal bent to form a tube by bringing its longitudinal edges together and having its inner and outer sides treated with an insulating and fireproof substance.

Distribution:—

THREE-WIRE ELECTRIC SYSTEM. E. M. Hewlett and W. B. Potter, Schenectady, N. Y., 554,270. Filed Sept. 10, 1895.

Allows a compound-wound generator to be thrown into either side of a three-wire system.

METHOD OF ELECTRICAL DISTRIBUTION. J. Burke, Schenectady, N. Y., 554,240. Filed Dec. 24, 1894.

A method of supplying from a single generator or group of generators current of different potentials in two or more electric circuits.

REGULATING PHASE RELATION OF ALTERNATING CURRENTS. E. J. Berg, Schenectady, N. Y., 554,230. Filed Oct. 8, 1895.

Regulating the phase relation of alternating currents so as to increase the efficiency of a system of distribution.

METHOD OF TRANSFERRING FEEDERS. J. Burke, Schenectady, N. Y., 554,239. Filed Dec. 24, 1894.

A method whereby feeders or any desired electrical apparatus may be transferred from a circuit of one potential to another.

Dynamos and Motors:—

ELECTRIC MOTORS. J. H. Guest, Boston, Mass., 554,365. Filed Dec. 23, 1893.

The energizing coils for the armature are mounted on the motor frame the same as are the field magnets.

COMMUTATOR BRUSH. O. P. Loomis, Bound Brook, N. J., 554,369. Filed Feb. 13, 1895.

The combination of alternately arranged layers or strips of metal of high conductivity and metal of high resistance, and a fastening device for securing the outer ends of said strips together, said device being insulated from said strips.

ARMATURE FOR INDUCTION MOTORS. A. L. Cushman, Concord, N. H., 554,617. Filed March 30, 1895.

A coil composed of an active high resistance portion and two or more low resistance portions, the high resistance portion and one of the low resistance portions being constantly in series and means for cutting out the high resistance.

CONTROLLER FOR ELECTRIC MOTORS. W. B. Potter, Schenectady, N. Y., 554,307. Filed Aug. 5, 1895.

Its object is to so arrange a controller that it may be adapted to give a greater number of combinations by which the speed of the motors may be regulated.

CONTROLLER FOR DYNAMO ELECTRIC MACHINES. W. H. Knight, Lynn, and J. W. Darley, Jr., Baltimore, Md., 554,276. Filed May 6, 1893.

A device for changing two or more dynamo electric machines, especially motors, from series to parallel connections.

Electric Railways:—

TROLLEY AND SWITCH FOR ELECTRIC RAILWAYS. L. L. Stimpson, Boston, Mass., 554,350. Filed May 2, 1890.

The normal position of the trolley and the point of contact is in a vertical line through the center of the car, held there by a spiral spring in the upper portion of the trolley pole, which lengthens it till the wheels strike the wire, and by a cord or tow line running from the upper end of the trolley pole to the forward end of the car.

ELECTRIC LOCOMOTIVE. C. F. Uebelacker, Cleveland, O., 554,353. Filed Sept. 6, 1893.

Means for supporting the motor and protecting the gearing.

UNDERGROUND CONDUIT FOR ELECTRIC RAILWAYS. W. S. Merkle, St. Louis, Mo., 554,450. Filed March 29, 1894.

Details of construction.

TROLLEY GUARD. J. H. Beazan, Milwaukee, Wis., 554,571. Filed March 19, 1894.

The combination of a trolley arm and its wheel of a pair of upwardly divergent guard arms, an arm upon the rear side of the trolley arm, and suitable connection between said extension and downward extensions upon said guard arms for normally sustaining the latter at substantially right angles to the wire.

Lamps and Appurtenances:—

MEANS FOR SUPPORTING AND MOVING ELECTRIC LAMPS. J. Dempsey, Berlin, Conn., 554,245. Filed April 1, 1895.

ELECTRIC LIGHT CABINET. E. L. Slocum, Pawtucket, R. I., 554,379. Filed March 21, 1895.

A convenient electric light apparatus for making medical examinations.

ELECTRIC LAMP HOLDER FOR BICYCLES. E. D. Rockwell, Bristol, Conn., 554,459. Filed May 10, 1895.

ELECTRIC ARC LAMP. J. A. Seaverns, Boston, Mass., 554,542. Filed March 14, 1895.

The combination with carbon holders and a clock mechanism adjusted for a predetermined rate, a coil to govern the clock mechanism, whereby the arc may be continuously maintained.

Measurement:

ELECTRICAL MEASURING INSTRUMENT. E. Thomson, Swampscott, Mass., 554,321. Filed Nov. 12, 1895.

An electrical measuring instrument in which a stationary electric circuit is so arranged as to cause rotation or a change in position of a movable coil or circuit.

Miscellaneous:—

METHOD OF PRODUCING MOLDS FOR PAPER-MAKING MACHINES. S. Crump, Spokane, Wash., 554,243. Filed May 21, 1895.

Relates to improvements in the manufacture of decorated paper and pulp boards. The matrix is deposited electrolytically.

METHOD OF AND MEANS FOR DETECTING GROUNDS. J. F. Kelly, Pittsfield, Mass., 554,275. Filed June 17, 1895.

Consists of two wings, each having the potential of one of the branches of the circuit, in combination with the needle whose potential is maintained at zero, lying within the influence of said wings.

MACHINE FOR CONNECTING ELECTRIC CONDUCTORS. H. J. Savory, Somerville, Mass., 554,541. Filed April 17, 1893.

A machine for connecting a small electric conductor to a larger one by upsetting one within the other; a hand-set provided with a clamping device rigidly attached to the hand set.

ELECTRIC TYPEWRITING MACHINE. J. L. Garber, Sidney, O., 554,594. Filed Feb. 26, 1892.

ELECTRIC GAS LIGHTER. H. G. Grier, Philadelphia, Pa., 554,622. Filed Nov. 7, 1895.

A jet of the mixed air and gas is projected in proximity to the point at which the spark is formed; adapted to Welsbach burners.

ELECTRIC HEATER OR RHEOSTAT. F. Kraemer and M. Kruger, Chicago, Ill., 554,632. Filed Jan. 7, 1895.

Comprises a prepared carbon resistance-stick hermetically embedded in a plastic body composed of one part of cement, two parts of sand and one part of water.

Switches, Cut-Outs, Etc:—

AUTOMATIC CURRENT REGULATOR. S. C. C. Currie, New York, 554,414. Filed May 23, 1895.

A process and apparatus for the automatic protection of secondary batteries during their charge and discharge so as to prevent their injury by a too rapid condition of change.

AUTOMATIC CUT-OUT FOR ELECTRICAL CONVERTERS. W. J. Greene, Cedar Rapids, Ia., 554,508. Filed Sept. 30, 1895.

A method of automatically cutting in and out electrical converters.

ELECTRIC SWITCH. H. B. Whitehead, Memphis, Tenn., 554,557. Filed Aug. 29, 1894.

A switch capable of being used as an ordinary switch and also as a cut-out for preventing the passage of an excessive current to a particular portion of the circuit.

DISTRIBUTING BOX AND FUSE PLUG. P. S. Brown, Toledo, O., 554,438. Filed April 19, 1895.

Relates to improvements in a "distribution box," and also to an improved fuse plug adapted for use both as an adjunct to said distribution box and independently of the same.

Telegraphs:—

TELEGRAPH RECEIVER. L. E. Oehring, Chicago, Ill., 554,395. Filed July 20, 1893.

The combination with an electromagnet and an armature lever, of a punch positively moved by said armature lever to perforate the tape, and a releasing dog for permitting the return of the punch independently of the movement of the armature lever.

Telephones:—

APPARATUS FOR TELEPHONE SWITCHBOARDS. C. E. Scribner, Chicago, Ill., 554,399. Filed July 2, 1895.

Permits complete or thorough connections between different lines to be made without leaving any unnecessary instruments or cables appended to the lines.

ARM-REST AND TABLE FOR TELEPHONES. F. Hofmeister, Racine, Wis., 554,488. Filed Aug. 5, 1895.

Comprises a frame, a folding table, an arm-rest, movable in the frame, a bell crank and a rod connecting the bell crank to an arm attached to the table and a spring adapted to fold up the table and elevate the rest.

REPORTS OF COMPANIES.

ANNUAL MEETING OF THE NEW YORK EDISON CO.

At the annual meeting of the Edison Electric Illuminating Co. of New York, held Feb. 11, 60,376 shares of the 79,380 shares, or about 75 per cent., were represented. The following directors were unanimously elected: A. A. H. Boissevain, R. R. Bowker, C. H. Coster, Charles E. Crowell, R. Fulton Cutting, Thomas A. Edison, W. E. Glyn, Arthur Curtiss James, D. O. Mills, Geo. Foster Peabody, W. A. Read, Francis S. Smithers, Spencer Trask. The only change from last year is the election of Mr. R. Fulton Cutting in the place of Mr. Geo. F. Gregory, deceased.

The president's report shows that at the end of 1895 the company had on its books 6,677 customers, and that it operated 271,123 16 c. p. lamps; 12,046 h. p. in motors, and 3,424 arc lights.

MONEY TALKS.

"Inclosed you will find an expression of our appreciation of "The Electrical Engineer." It is a money order for $3 for our 1896 subscription. Money talks."

Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

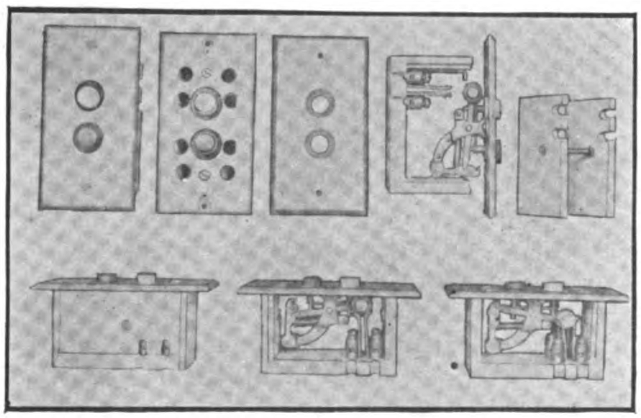
THE SOUTHWARK FOUNDRY AND MACHINE CO.

The catalogue we have received from the Southwark Foundry and Machine Company of Philadelphia is remarkably well done. The binding would not disgrace a library volume, while the type and illustrations are unusually good. Altogether, the get-up of the work is such as to encourage its preservation for permanent reference. Much space is given to a description of the specialty of the company, Porter-Allen engines of various types, while vertical, blowing, reversing and waterworks pumping engines, compressors for natural gas, centrifugal pumps and hydraulic and marine machinery and ordnance are duly treated.

The works of the company are exceptionally well equipped for the turning out of the highest class of foundry and machine work. The machine shops have an aggregate floor space of 65,500 square feet. The main erecting shop, which is 76 feet wide by 253 feet long, is equipped with two electric cranes, each capable of handling fifty tons. The iron and brass foundries, the boiler, pattern and smith shops are also fitted with the most approved modern appliances.

THE PAINTER-MORRISON FLUSH SWITCH.

The Morrison Southern Electric Co. of Baltimore, Md., have placed upon the market a novel push-button flush switch, which possesses several features not shown in any switch heretofore brought to our notice, and is claimed by the inventor, Mr. Geo. E. Painter, to be the only flush switch which combines simplicity of construction with perfection of mechanism. Porcelain being adopted for the base and sides, makes the switch entirely fire and damp proof. They can be easily wired without taking apart. Even after placed in the wall the wires can be easily adjusted by simply removing the face-



The Painter-Morrison Flush Switch.

plate, which is also made in various finishes, to harmonize with the decorations of the room, and need not be put on until all other work is done. They can be placed in groups, being accessible in all their parts, and are so constructed that they are positively non-arcing.

Both black and white buttons are always out, and indicate by the touch whether on or off, and are easily operated. All parts are interchangeable. The make and break arc is quick, and the connection is positive. The switch is 10 ampere, double pole.

MICANITE IN FOREIGN LANDS.

The foreign business of the Mica Insulator Company has grown largely during the last six months, so that they have increased their facilities for manufacturing their well-known insulation, Micanite, the company having made additions to their factory in London. European manufacturers of electrical machinery are using Micanite largely in the construction of their various designs of apparatus, and the company is to be congratulated upon the success which their insulation has met with in foreign countries.

THE JEWELL BELTING COMPANY, of Hartford, Conn., has issued a new pamphlet on their pulley-covering material which they will be glad to supply to any engineers of light or power stations on application. It is worth having.

THE GORDON-BURNHAM PRIMARY BATTERY.

A primary battery, which has attracted wide attention for its extremely successful and varied work where a battery whose action is constant is necessary, is the Gordon battery, which has been on the market for the past year. This battery has made a record for itself among steam railroads, which use electric signals where the very highest grade of battery has to be used to obtain reliable results.

The Gordon battery, an illustration of which we show on this page, is entirely different from any other battery now in use. For the operation of railway signals a successful primary battery must be one of great constancy and absolutely reliable under all conditions of weather. This has been demonstrated to be true of the Gordon cell throughout the United States, some of these cells being in use on every steam railroad in this country. The battery cannot be frozen, and therefore requires no protection from the cold, such as is usually given to the gravity cell in this service.

The construction of the cell and the elements used are entirely new and novel. They are made in two sizes, No. 1 being of the standard size—6x8 inches—and the No. 2 size 4½x6 inches, and they are made either with glass or steel jars. The elements used are a specially prepared copper element, which is the highest known depolarizer, which is contained in a perforated metal cylinder. The zinc element is made from highly amalgamated and chemically pure rolled zinc. The solution is

The Gordon-Burnham Primary Battery.

made from a pure hydrate of soda, manufactured from common salt by an electrolytic process, which eliminates all impurities that would impair the strength of an alkaline solution.

The Gordon cell is equally good for open or closed circuit work and will stand on open circuit for an indefinite period without any deterioration, there being no local action whatever. The cell is especially adapted for all forms of electric transmission of sound. For telephone service a cell is required with little or no polarization, one that is long-lived and requires no attention. The Gordon battery being capable of discharging a constant current, does not polarize, and therefore for telephone service it can be used constantly day and night, if necessary, without any noticeable impairment of the quality of transmission, which would be certainly noticed in all known forms of open circuit batteries. The cell is well adapted for the operation of gas engine igniters, and, we may say, that they are used to-day throughout the country in this service. They are also particularly well adapted for all household service, call bell work, etc.

For fire alarm service the battery has made an excellent record in all the large cities of the country, and is being rapidly introduced into the smaller cities and towns. This battery has been widely indorsed by many of the leading steam railroads and manufacturing electricians throughout the country, and the company are in receipt of a number of letters, which speak of the battery in the very highest terms, and in many instances order duplicate equipments. These letters show conclusively that the battery has more than fulfilled all the claims made for it by the company, and that for the work intended it is undoubtedly one of the very best batteries that has ever been put on the market, and is indeed guaranteed by the manufacturers to do three or four times as much work as any other form of primary battery. They are manufactured and sold by the Gordon Burnham Battery Company, 82 West Broadway, New York.

BRADY'S ARC CUT-OUT BOX.

There is perhaps no better known apparatus than the Brady mast arm, of which Mr. Brady's new catalogue informs us there are no less than 20,000 in use to-day in the United States and Canada, and in Europe and South America. This arm is too well known to require description at this time, but

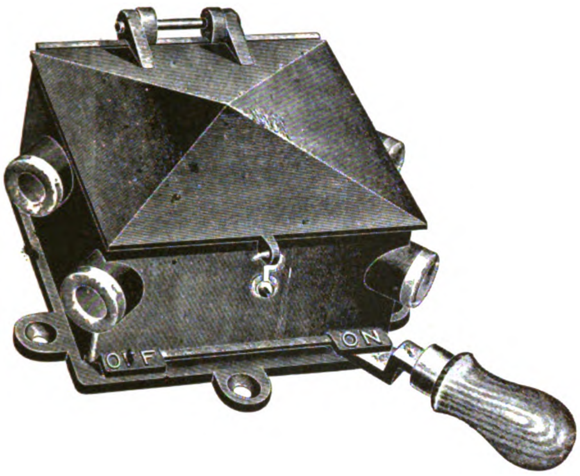


FIG. 1.—BRADY ARC CUT-OUT BOX.

the catalogue contains illustrations of a variety of these arms designed to meet all possible conditions. Thus we find illustrations of the regular side mast arm, in which the lamp is lowered to be trimmed; the improved high pole mast arm, in which the lamp is slid towards the pole and trimmed by the trimmer at the top; and a variety of others.

Among the arc cut-out boxes made by Mr. Brady we note the type shown in the accompanying engraving, Fig. 1, intended for inside use, to be screwed to the wall. When intended for placing on outside exposed places, it is attached

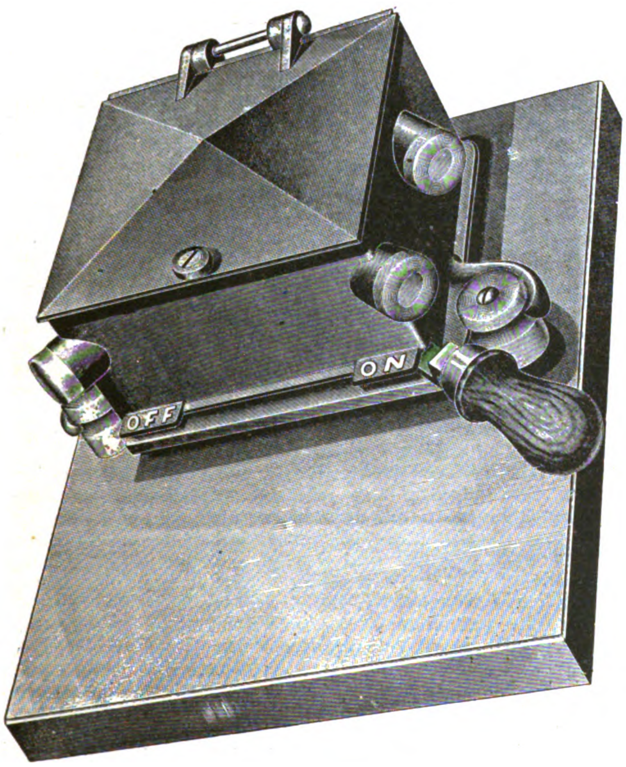


FIG. 2.—BRADY ARC CUT-OUT BOX.

to a pole or building by lugs that fit into the grooves of a No. 5 porcelain knob, thus insulating the box perfectly from the building or pole. See Fig. 2.

Various styles of cut-out hanger boards, thread and house brackets, break arms, lamp hooks, spark arresters, etc., go to make up a most complete line of arc lamp accessories. The Brady factory is situated at New Britain, Conn.

THE CROWN WOVEN WIRE BRUSH.

The advantages of using woven wire brushes are known to almost every one having the care of electrical machinery, but one fault has been their liability to spread at the ends, especially in wide brushes, which causes the brush to cover more segments on the commutator than desired, and this trouble, on some machines, causes sparking and heating.

The Crown Woven Wire Brush Company of Salem, Mass., have overcome this fault in their new brush, the Crown "K," which is illustrated in the accompanying engraving, Fig. 1. This brush is made with a core of very fine braided wires, placed diagonally in the center, with a covering of just as fine cloth, woven like lace, giving more ventilation than in ordinary weaving. It is then sewed with strong thread, which prevents it spreading at the ends.

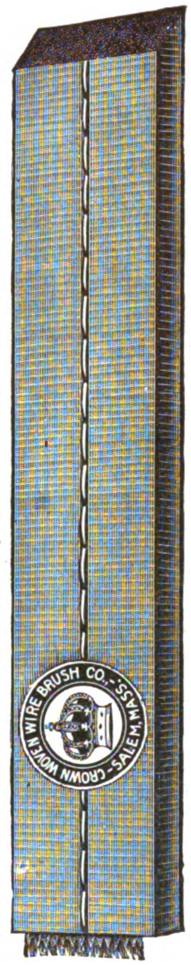


FIG. 1.

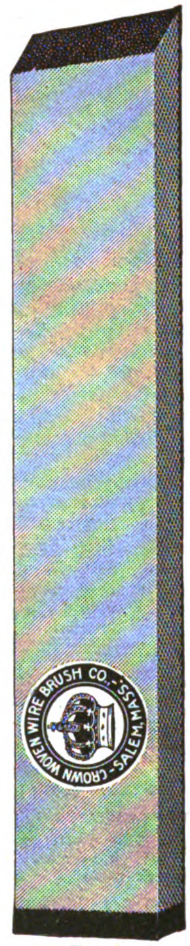


FIG. 2.

This brush differs entirely from other American-made brushes, and is somewhat similar to the imported German brush, and, owing to the duty on the imported, they are sold at a lower price. This company also make the ordinary brush, which we illustrate in Fig. 2, called the "Crown." Their sales are rapidly increasing and their goods are used all over the United States and in many foreign countries.

H. B. Coho & Co. are their New York agents, and carry a large stock of their goods. The Metropolitan Electric Co. have taken the Chicago agency and will shortly carry the largest stock of woven wire brushes in the West.

NEW ENGLAND NOTES.

Boston is to have another electrical supply house, the New England Electric Supply Co. having opened offices at No. 49 Federal street. They have secured a well-lighted and capacious store at this address and will doubtless be heard from more directly and vigorously in the near future.

THE BERLIN IRON BRIDGE COMPANY, of East Berlin, Conn., have just completed for the Silver Springs Dyeing and Bleaching Company, of Providence, R. I., three buildings made with steel frames and corrugated steel coverings, an engine house, a box shop and a boiler-room. The Berlin Company have also lately completed a fire-proof boiler-room for the Passaic Print Works, at Passaic, N. J.

THE RIVAL AUTOMATIC OILING RETURN SYSTEM AND PURIFIER AND STORAGE TANK.

OPERATORS of large steam plants and central station managers know how dividends are made or marred by the observance or omission of economies. The oil bills in the old style central station used to cut a heavy figure in the early days, but the application of the oil filter, together with improved oiling systems, have removed one of the large minor charges from the best equipped modern stations. Among those who have given special attention to oil economy are the Messrs. F. E. Bailey & Co., of Betz Building, Philadelphia, manufacturers of the Rival Oil Purifier. In this apparatus the impurities are removed by subjecting the oil to gentle heat, and no filtering compound or material of any kind is employed. The impurities are deposited at the bottom of the tank and can be drawn off without disturbing the continuity of operating of the apparatus.

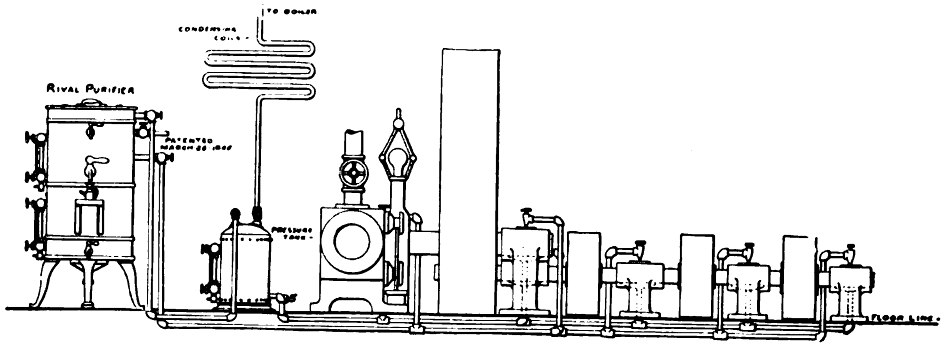


Fig. 1.—Rival Automatic Oil Return System.

The automatic oiling return system used in connection with the "Rival" purifier is shown in Figure 1. As will be seen, a small pipe is connected to each bearing with independent sight feeds from an oil main that is connected to an oil purifier or pressure tank, dispensing with oil cups and their attention, which is very expensive in large plants. The drip from each bearing is conveyed by a small pipe to purifier or to a pressure tank, where it is returned to the purifier, making an entirely automatic and inexpensive system of lubrication and filtration.

NEW YORK NOTES.

THE INTERNATIONAL ELECTRIC CO., 76 Beekman street, makers of Ruhmkorff coils, have felt the demand for induction coils caused by experiments with X-rays. At present they have but one odd-sized coil in stock, while orders on their books are such as will keep them steadily busy for another week or so. The coils present uniformly a handsome appearance.

THE NATIONAL CONDUIT MFG. CO. of New York are issuing an interesting circular to electric light and railway companies, telephone and telegraph companies, and, in fact, to any company which may be contemplating placing their wires underground. The circular is interesting, in the particular that it gives some data on the amount of conduit already laid in many cities by the National company. Philadelphia heads the list with 5,000,000 feet, Boston comes second with 3,000,000 feet, Chicago third with 2,000,000 feet, and New York fourth with 1,900,000 feet. Other cities to the number of about twenty-five are enumerated, which have used amounts varying from 50,000 to 500,000 feet, and a number of other cities, which have used smaller amounts. Many of the most important customers of the National company are also mentioned. The National company keep always in stock about half a million feet of 3-inch conduit, and undertake to start work with 500 men in any city in the country in ten days from receipt of order.

THE MOORE ELECTRICAL CO.

Our issue of Feb. 5, containing the pictures taken by the Moore "etheric" light from vacuum tubes, omitted to give the full list of the officers of the company. These are as follows: E. J. Wessels, president; J. Livingston, vice-president; Leopold Wallach, treasurer; D. McFarlan Moore, electrical engineer and general manager.

ADVERTISERS' HINTS.

THE ELECTRIC APPLIANCE CO. are advertising their "Three Ps," which stand for Packard Lamps, Paranite Wire and Packard Transformers. They claim progress is particularly exemplified in the above-named specialties.

McINTOSH, SEYMOUR & CO., in a list of recent sales, enumerate over 16,000 h. p. of their gridiron valve engines. This style of engine is well adapted to street railway service, and they are installed in some of the largest power houses in the United States. Messrs. J. A. Grant & Co., of Boston, are their New England agents.

THE MICA INSULATOR CO. state that three-quarters of the manufacturers of electrical machinery use "Micanite" as the insulation in the construction of their various designs of apparatus. Micanite and Empire cloth and paper are some of their specialties.

THE GORDON-BURNHAM BATTERY CO. give nine excellent reasons for the complete success of the Gordon battery. Every cell is guaranteed.

THE NATIONAL UNDERGROUND CABLE CO. is now manufacturing the well-known Norwich wires and cables. They will be glad to respond to any requests for information from their headquarters in the Times Building, New York.

THE ELECTRIC STORAGE BATTERY CO.'s "ad." shows an installation in one of the large central stations of this city.

THE WESTON ELECTRICAL INSTRUMENT CO. call attention to their ground detectors and circuit tester. Their portable instruments are recognized the world over as standard. A catalogue describing these and other makes of their reliable instruments may be had upon application.

WESTERN NOTES.

THE LESCHEN-MACOMBER-WHYTE COMPANY have opened offices at 19-21 South Canal street, Chicago, where they will have charge of the business in that territory of A. Leschen & Sons, St. Louis, Mo. They will keep a complete stock of wire rope and cordage blocks, iron, steel, and bare and insulated copper wire and other sundries. F. B. Macomber and George S. Whyte, who are well-known men in this business, will be in charge.

MR. GEO. W. CONOVER, Western Manager of the Perkins Electric Switch Manufacturing Co., Hartford, Conn., recently made a trip in the Northwest, where he did some nice business and reports the future outlook as quite encouraging.

THE INDEPENDENT ELECTRIC CO., Chicago, moved their general office from their factory at Thirty-ninth street and Stewart avenue to 153 Lake street, where they are more easily reached than at their old address. Mr. W. R. Goodman takes care of this end of the business.

THE ELECTRIC APPLIANCE CO. have established quite a reputation for bringing out original advertising novelties. Their latest scheme in this line is certainly a good one, and consists of a complimentary duplicate order book. The book consists of fifty original and duplicate order sheets, bound in a special cover in such a manner that a customer has an impression copy of each written order made at one writing. The books are furnished complete with carbon paper ready for use, and will be sent on application.

EMERSON MOTORS.—The new alternating current power motor of the Emerson Electric Mfg. Co., St. Louis, are rapidly coming to the front as highly successful machines. New orders are coming in daily, and inquiries are received from all over the country. They are particularly adapted for the low alternation systems now being largely introduced, although fully up to the manufacturers' claims on 16,000 alternations, and the above company's guarantee on each machine is sufficient assurance to the most skeptical that a commercially efficient motor for alternating power purposes can now be obtained.

Department News Items will be found in advertising pages.

THE
Electrical Engineer.

Vol. XXI. FEBRUARY 26, 1896. No. 408.

Electric Transportation.

THE WESTINGHOUSE—BALDWIN ELECTRIC LOCOMOTIVE.

As announced in our last issue, the Westinghouse Electric and Manufacturing Company has received the first electric locomotive manufactured under the arrangement entered into some time ago between it and the Baldwin Locomotive Works, of Philadelphia.

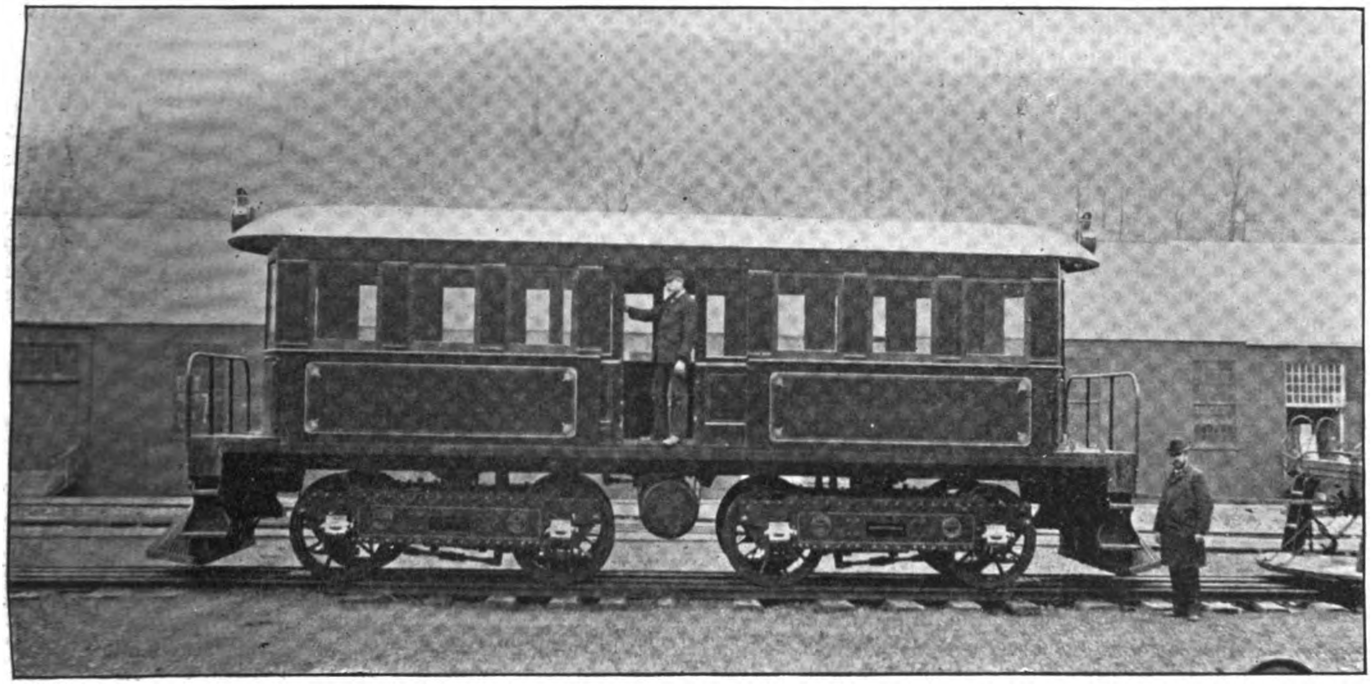
In appearance the locomotive is much different from the steam locomotive, and it also shows radical departures in construction from every electric locomotive hitherto manufactured. It is 38 feet long and 9 feet across. All the operating parts of the locomotive have been placed on the truck and the body of the car will only contain the controlling apparatus, and can be utilized as a receptacle for such appliances as are usually carried by any train. It may also be used as a freight or baggage car.

One of the characteristic features of the locomotive is the truck, which has eight wheels and is constructed in a very substantial manner. The wheels are 42 inches in diameter. There will be four motors of 200 horse-power each, connected to the axles of the locomotive. Thus the entire weight of the locomotive will be placed upon the truck, thereby becoming available for adhesion. This feature of construction will be readily recognized as a very advantageous one over steam locomotives, in which only a fraction of the weight is available for adhesion.

The locomotive completely equipped will weigh 160,000 lbs. The motors are geared, which method has been decided upon so as to enable the company to use more efficient and durable motors and also greatly reduce the cost of the locomotive, which we understand is in the neighborhood of $16,000.

The Baldwin-Westinghouse combination is constructing engines for all kinds of purposes. The one described here is the regular passenger engine, rated at 1,000-horse-power capacity. Then there will be locomotives made to be used in mines. The latter will have six driving wheels and the superstructure will consist of a sheet iron cab. The switching locomotives will also have a cab as a superstructure. There will also be manufactured locomotives for tunnel work, suburban traffic and rack locomotives, as well as for elevated railroads.

It is expected that within a few days the second locomotive, as completed by the Baldwin Company, will be received at the East Pittsburg factory of the Westinghouse Company. This last one will be of the elevated railroad type and is an example of a motor car of the Manhattan Elevated Railroad of New York.



Westinghouse–Baldwin Electric Locomotive for Trunk Line Work.

As far as the speed of these new locomotives is concerned, it may be stated that the motors have been geared to produce a speed of 75 miles an hour, although it may reach 125 miles an hour, if it were demanded. All Westinghouse-Baldwin locomotives will be equipped with air brakes, which will be operated in the usual manner by an air pump, which is underneath the car, and which will be driven by an electric motor.

The Westinghouse-Baldwin locomotives have been designed so as to be utilized with any method of electric traction. They can be used with the trolley system, the third rail system, the Westinghouse electro-magnetic system and they can also be

utilized in connection with the Tesla polyphase system. It is interesting to note that since it became known that the Baldwin-Westinghouse companies are constructing electric locomotives, inquiries have come from all over the world for such machines, indicating the wonderful demand for such locomotives.

CAN ELECTRICITY SUPPLANT THE STEAM LOCOMOTIVE ON TRUNK RAILWAYS?—II.

BY

Wm. Baxter Jr.

TESTS of the engine drawing the Empire State Express on the New York Central Railroad have shown results as high as 3⅛ pounds of coal per horse-power hour, but the conditions under which such tests have to be made are such that it is very difficult, if not actually impossible, to obtain exact results. The power developed by locomotives, as shown by the indicator cards, can be considerably out of the way. This fact is recognized by steam engineers, and few, if any, of them would undertake to claim that the results of these tests represent the average working efficiency of locomotives in high-speed service. Even if the indicator diagrams are accurate, which could only be the case if they were taken at a time when the speed was neither decreasing nor accelerating, the results would be better than the average performance, for the very simple reason that whenever tests are made the engineer and fireman do their best to make the coal consumption as low as possible.

It is very doubtful, in my mind, whether the average every-day work of high-speed passenger locomotives can show a result much below four pounds per horse-power per hour. Now the efficiency of such engines is higher than that of engines used for local traffic, because one of the factors upon which the economy of locomotives depends is the high piston speed in consequence of which the loss due to cylinder condensation is greatly reduced; therefore the higher the speed, the higher the efficiency. As freight trains run at a much lower rate of speed than adopted in local passenger service, it follows that the efficiency of freight locomotives must be still lower than that of local passenger engines.

Considering all these facts it would seem reasonable to assume that the coal consumption of locomotives will average in actual service about four pounds per horse-power per hour for express engines; five pounds for local passenger, and six pounds for freight. There is another class of work for which locomotives are used in which the coal consumption per horse-power of useful work performed is very great; just how great it is impossible to say, but in all probability it is in the neighborhood of 20 or 25 pounds per horse-power hour, and in some cases may go even higher. The work referred to is that of drilling engines, used to shift cars and trains around stations and freight yards. The work of these engines cannot be taken into consideration in an estimate of the relative efficiency of locomotives and electric motors, because their wastefulness is due to the fact that while they are burning coal all the time they are only developing power-moving trains for short periods of time at intervals of longer or shorter duration. But the part that these engines play in determining the relative cost of operating a railroad by steam or electricity is important from the fact that the work they do forms quite a large percentage of the total mileage of the road; therefore their bearing upon the subject will be more fully considered later on. What concerns us here is the economy of locomotives in motion as compared with large stationary steam engines.

From the foregoing it will be seen that the great economy in coal consumption claimed for electricity is not fully substantiated by facts. Two pounds per horse-power hour, which was taken as the maximum consumption with large stationary engines, is in reality about the best result that can be counted upon in practice. As to locomotives, six pounds per hour does not represent the average; on the contrary, it may be taken as the maximum consumption, or nearly so. A fair average, taking all things into consideration, would no doubt be about five pounds per hour; therefore, instead of using six pounds of coal in a locomotive to do the same amount of work that a large triple expansion engine will do with about one and a half pounds, it only requires five pounds in the former to do as much work as the latter will do with two pounds. The ratio instead of being 4 to 1, is 5 to 2 in favor of the stationary engine.

But this is the direct ratio between the stationary engine and the locomotive, and as the energy of the former has to be converted and transmitted to the motors on the track, the actual working ratio will drop to about 3 to 2, assuming the efficiency of conversion to be about 60 per cent. It can therefore be said that the actual amount of coal required by electric motors to develop a unit of energy on the track would be about two-thirds of that required by locomotive.

As to cheap and dear coal, it will be found that the difference in cost between the two, to railroad companies, is not very great, especially to those located at a considerable distance from coal mines. The average price of coal at the mines is about 95 cents to $1 per ton. A very cheap grade would probably cost about 25 cents per ton. The cost of coal to railroads not located directly in the coal regions ranges from $1.50 to $3 per ton, the average being about $2.25. The cost of transportation for a cheap grade of coal would be just the same as for the best; therefore the only difference in the actual cost of such coal to the railroad companies would be the difference in first cost at the mines, which would be about 70 or 75 cents per ton. In other words, dear coal would cost on an average about $2.25 per ton and cheap coal about $1.50. As the locomotive consumes three pounds of coal to develop the same amount of energy that the electric motor would develop with two pounds, we have the following as the cash relation between the two systems:

$$\frac{2\times 1.50}{3\times 2.25} = \frac{3.00}{6.75} = 44.4 \text{ per cent.}$$

We thus see that, taking into consideration the difference in coal consumption and also the difference in the price of the two grades used, the cost of a unit of energy developed on the track by electric motors would be about 44½ per cent. of what it is with steam locomotives, so far as the coal bill alone is concerned. As coal, even of the best quality, is a very cheap article, when its cost to most railroads is considered, it follows that a very large consumption would be required to enable the saving that electric motors could make to amount to a sum large enough to justify the abandonment of steam.

The coal consumption of locomotives per train mile varies within wide limits, ranging from about 45 pounds per mile for light passenger service to 100 and more for heavy freight trains; an average of 80 pounds per train mile would certainly not be too high. The cost of this amount of coal at $2.25 per ton would be about 8 cents. As the cost by electric motors would be only 44½ per cent. of this amount, the saving per train mile would be $4\frac{44}{100}$ cents.

The average yearly run of a locomotive is about 30,000 miles; therefore the annual saving in coal per locomotive would be something over $1,300. This saving alone would not be enough to make the adoption of electricity justifiable on roads now in operation; whether it would enable new roads to use the system and compete with steam, would depend upon the relative cost of installation of the two systems.

At a first glance the natural conclusion would be that the electric system would be by far the most costly. That it would cost more, there appears to be no room for doubt, but the dif-

ference would certainly not be as great as a superficial inspection would lead one to believe. Power stations would be required with their expensive machinery. The trolley lines and feeders would also represent a large outlay; but on the other hand, the motors used to haul the trains would cost very much less than locomotives. The repair shops would also be much smaller than those required for a steam equipment, and would be supplied with a smaller amount of machinery and tools for doing repair work. Water tanks and coal sheds along the line of road would not be needed. An electric motor would make more miles per day than a steam locomotive; therefore a smaller number would be required to do the work of the road.

Now when all these various items are added together it will be found that they will go a long way towards offsetting the cost of power stations, trolley lines and feeders. It is therefore probable that a close estimate of the relative cost of equipping a new road with steam or electricity would show that the difference in favor of steam would be only a small percentage, so small, in fact, that the reduced cost of operation, due to the saving in coal alone, would render the electric system more profitable, except in parts of the country where the cost of fuel is considerably below the average price here assumed.

A careful consideration of all the foregoing will lead to the inevitable conclusion that the saving in the coal bill, while sufficient to turn the scales in favor of electricity, when the equipment of new roads is considered, would not justify the replacement of steam on roads already built, except in sections of the country so remote from coal mines that the cost of fuel would be much greater than that upon which these estimates are based.

This at once suggests two phases of the subject. First, we have the question of the advisability of adopting electricity on new roads, and in this direction we find that unless the difference in first cost is much greater than would seem probable, the saving in coal bill alone would render the system the most profitable, even if the cost of coal were less than the average price here taken.

Second, we have to consider the subject in its relation to roads now using steam. Then the question that arises is, Will it pay to throw away the locomotives and install an electric plant? In the case of new roads the saving in fuel bill only has to compensate for the difference between the cost of steam and electric equipment; but with roads already built, this saving must be enough to pay a fair return on the entire cost of the electrical equipment, or else its adoption would not be profitable. But so great a saving would not be probable except on roads located in parts of the country far removed from coal fields, where, on account of the increased cost of transportation, the item of fuel would be a much greater percentage of the total operating expenses than the general average.

In order to be able to form a fair estimate of the bearing that the saving of a portion of the coal bill may have on the total operating expenses of a railroad, it is necessary to know what percentage this item is of the whole expenditure. Fortunately I have before me the reports of several hundred steam railroads and therefore am able to give actual figures as to total operating expenses, fuel, mileage, etc., from which deductions may be drawn. (See Table 1.)

In Table 1, the operating expenses are given in columns 1 and 2, for passenger and freight traffic, respectively. In columns 3 and 4 are given the amounts expended for coal. These figures are only given for the first four roads, because the reports from which this data has been obtained do not give the amounts allotted to each kind of traffic for the other roads. In columns 5, 6 and 7 are given the mileage of passenger, freight and switching trains for all the roads. And in column 8 is given the percentage that the coal bill represents of the total operating expenses in each case.

The percentages in the last column show that the cost of coal becomes a more important factor as the distance of the road from the coal producing centres increases. Thus the percentage on the Pittsburg, Cincinnati, Chicago and St. Louis Railway is only a trifle more than 6, while on the Boston and Albany Railroad it is 11½. The figures do not entirely harmonize. For example, the percentage for the New York, New Haven and Hartford Railroad is 9, which is the same as that of the Pennsylvania Railroad, yet one is some distance removed from the coal supply, while the other passes within a stone's throw of the mouth of the mines. These inconsistencies can be accounted for in a very great measure by the relation between freight and passenger traffic. Those roads on which the mileage of freight trains is high, as compared with the total show a much higher percentage of coal cost to total operating expenses than roads on which it is low. A striking illustration of this fact is the Albany and Susquehanna Railroad, where the coal bill amounts to over 18 per cent. of the total operating expenses. In this case the passenger train mileage is 603,915, while the freight train mileage is 2,027,493. A comparison of the passenger train mileage with the freight train mileage will show at once why the percentage of the coal cost is not proportional to the distance of the road from the coal supply in every case. Thus, the percentage on the New York, New Haven and Hartford and the Pennsylvania roads is the same, whereas it should be much higher on the former. But by looking at the train mileage, we see that while on the latter road the freight mileage is much greater than the passenger, on the former the conditions are reversed. The Albany and Susquehanna Railroad, although not very far from the coal mines, spends for fuel an amount that is more than 18 per cent. of the total operating expenses; but about five-sixths of this amount is allotted to freight service.

The table shows that the coal consumption of freight locomotives is much greater per horse-power than the figures claimed for high-speed passenger engines, and also shows that the opinion that has been generally entertained that electricity would not have much of a chance of competing with steam for freight service, but would have to confine its efforts to passenger traffic, is not well founded; in fact, if it can compete with steam at all it can compete in heavy freight traffic. There are several reasons for this, one of which has already been mentioned, and that is that on account of the slow speed of freight locomotives, the efficiency is much lower than that of passenger engines, especially those used for express service.

TABLE I.—Operating Expenses, Coal Consumption, Mileage and Percentage of Coal Consumption of Total Operating Expenses.

	Operating Expenses.		Coal.		Mileage.			
	1. Passengers.	2. Freight.	3. Passengers.	4. Freight.	5. Passengers.	6. Freight.	7. Switching.	8. Per Cent.
Albany and Susquehanna Railroad	$384,054.38	$1,896.117.84	$67,090.21	$345,970.95	603,915	2,027,493	13,193	18.1
Boston and Albany Railroad	3,115,868.15	4,014,235.15	383,851.18	431,119.48	3,376,841	3,554,534	234,539	11.5
New York Central	10,906,435.80	19,725,297.07	1,283,835.96	1,747,913.81	14,323,229	14,194,486	11,754,546	10
New York, Lake Erie & West. R. R.	4,541,188.11	15,730,507.46	381,822.88	1,502,719.25	5,764,965	10,601,372	3,400,179	9.3
Boston and Maine Railroad	....	....	....	....	6,926,620	4,605,340	....	10
New York, New Haven & Hartford R.R.	....	....	....	....	6,318,706	3,709,990	141,019	9
Pennsylvania Railroad	....	....	....	....	14,908,880	20,400,355	10,298,317	9
Reading Railroad	....	....	....	....	4,780,088	8,238,877	5,071,394	8
Lake Shore Railroad	....	....	....	....	*1,524,029	2,440,698	1,389,918	10.5
Pittsburg, C., C. & St. Louis Railroad	....	....	....	....	1,420,792	2,189,321	853,282	6.1

In State of Ohio only.

But in addition to this lower efficiency there is another loss due to the fact that freight trains are very often side-tracked for a considerable length of time and coal is burned without doing work. Then again, at the various points along the line where freight has to be delivered the train has to stop and wait until the cars are disconnected and the train made up again.

TEST OF RAIL BONDS.

WE print below the result of some tests made of various types of rail bonds by Mr. Robert Bunning, Master Mechanic of the Buffalo Railway Company. These tests were made at the power house on Jan. 23, 1896. All of the instruments were of the Weston type, and had just been recalibrated by the Weston Company.

In these tests current was sent through the rails and joints, and its amount and the drop noted. A 9-inch rail weighing 90 pounds to the yard showed a drop of 0.0025 volt per foot, with 250 amperes. A 6¼-inch rail weighing 62½ pounds to the yard showed a drop of 0.005 volt per foot, with a current of 350 amperes. In these tests a milli-voltmeter was used whose entire range was 0.04 volt, so that extreme accuracy was possible:

COPPER BONDS.

Joint of 90 pound girder rail, 6 feet long, with one No. 100 Chicago bond 6 inches long through rail base. Contacts clean, tight and new.

Amperes.	Total drop.	Less drop of rail.	Net drop of bond only.
125	0.04 volt.	0.0075 volt.	0.0375 volt.
1,200	.23 volt.	.072 volt.	.208 volt.
1,400	.35 volt.	.084 volt.	.266 volt.
1,450	.40 volt.	.087 volt.	.313 volt.

Bond very hot at end of tests.

Same joint with same Chicago bond and one No. 80 copper wire, 30 inches long newly fastened with channel pins.

Amperes.	Total drop.	Less drop of rail.	Net drop of bond only.
200	0.04 volt.	0.012 volt.	0.028 volt.
1,200	.28 volt.	.072 volt.	.178 volt.
1,500	.30 volt.	.09 volt.	.21 volt.

esistance of rail .00001 ohm per foot

PLASTIC BONDS.

Joint of 90 pound girder rail, 5 feet long, with standard type of plastic bond between web of rail and angle-plate on one side only.

Amperes.	Total drop.	Less drop of rail.	Net drop of bond only.
160	0.01 volt.	0.003 volt.	.01 volt.
200	.02 volt.	.01 volt.	.01 volt.
950	.08 volt.	.0475 volt.	.0325 volt.
1,200	.095 volt.	.06 volt.	.035 volt.
1,400	.11 volt.	.07 volt.	.04 volt.

Bond cold at end of tests.

PLASTIC PLUG BOND.

Joint of 62½ pound girder rail, 4 feet long, on chairs with Tee rail under joint; one pair of ⅝-inch holes through chair and rail base into top of Tee rail; holes amalgamated and filled with plastic alloy. Resistance of rail, 0.000014 ohm per foot.

Amperes.	Total drop.	Less drop of rail.	Net drop of bond only.
190	0.015 volt.	0.01064 volt.	0.00436 volt.
400	.0425 volt.	.0224 volt.	.020 volt.
1,200	.13 volt.	.0672 volt.	.0628 volt.
1,500	.17 volt.	.084 volt.	.086 volt.

Bond cold at end of tests.

Same joint with one pair of ⅝-inch holes on each side of rail; amalgamated and filled with plastic alloy.

Amperes.	Total drop.	Less drop	Net drop of
190	0.0125 volt.	0.01064 volt.	0.00186 volt.
1,100	.10 volt.	.0616 volt.	.0384 volt.
1,200	.11 volt.	.0672 volt.	.0428 volt.
1,300	.115 volt.	.0728 volt.	.0422 volt.

Bonds cold at end of tests.

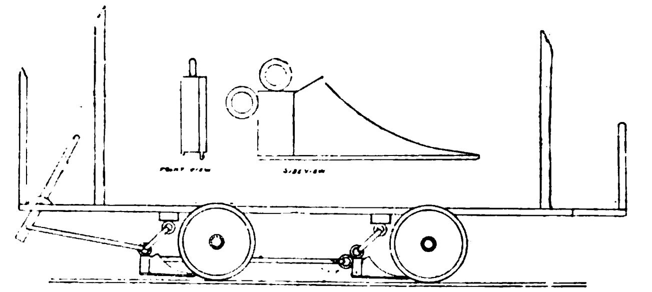
Joint of 62½ pound rail, 3 feet long, with horizontal hole ⅞ inch in diameter in meeting ends of rails, with grooved steel dowel pin, amalgamated and filled with plastic alloy.

Amperes.	Total drop.	Less drop of rail.	Net drop of bond only.
200	0.011 volt.	0.0084 volt.	0.0026 volt.
340	.0225 volt	.0145 volt.	.008 volt.
1,000	.08 volt.	.042 volt.	.038 volt.
1,300	.11 volt.	.0546 volt.	.0554 volt.
1,500	.13 volt.	.063 volt.	.067 volt.

Bond cold at end of tests.

THE PARSHALL EMERGENCY BRAKE.

THE accompanying engravings illustrate an emergency brake adapted for electric street cars, designed by Mr. W. S. Parshall, of Detroit, Mich. As will be seen, the shoes when not in use are suspended from the car by heavy links, and are held from the wheels by the rod connecting with the brake lever. When it becomes necessary to use the brake, the lever is released by the motorman or driver of the car, and the shoes drop in front of and under the wheels, blocking, and



THE PARSHALL EMERGENCY BRAKE.

at the same time raising them clear of the track, thus preventing their becoming flat by grinding on the rails.

The shoes are provided with a bead which runs in the groove of the rail to prevent derailment of thé car. This brake is designed solely to be used in cases of emergency and is not intended to replace the ordinary brake in use at present.

STREET-CAR OPERATION IN CHICAGO.

A fact of large public significance may be gleaned from the mass of dry figures representing the fiscal operations of the three big street railway companies of the city for the year 1895. This fact is that electricity is more than ever the coming propulsive power for surface travel. On the north side, for the first time in the history of the city, perhaps for the first time in any history, electric trolley cars are now being operated more cheaply than cable cars. On the south side the car-mile cost of running cable cars rose from 9.972 cents in 1894 to 10.240 cents in 1895, while the car-mile cost of electric cars fell from 16.904 cents in 1894 to 14.776 cents in 1895. Moreover, the passenger traffic of the south side cable lines showed a decrease of over 1,000,000 passengers as compared with 1894, while the traffic of electric lines showed a large increase. These facts point to one conclusion—namely, the substitution of electricity for the cable. It must be considered, too, that the companies have spent enormous sums on their electric lines. The City Railway Company has spent $2,000,000 in that way, and proposes to spend $2,000,000 more. The West Chicago Company has spent over $2,000,000 and the North Chicago Company a very large sum. The larger the plant the more cheaply in proportion it can be operated. It is not unlikely that the results of the current year will point irresistibly to the discarding of the cable as a means of street-car locomotion.

While street car managements are being carried toward an extension of the application, the public should be moving as unmistakably toward a protection of itself against further encroachment by the trolley system. The public may make up its mind that electric propulsion is coming in more and more. It should also make up its mind that it will not come any further in the shape of the unsightly and dangerous overhead trolley.—Chicago News.

COAL CONSUMPTION ON FRENCH ELECTRIC TRAMWAYS.

Comparative figures of the coal consumed per car-mile run on French tramways, employing different methods of propulsion, are contained in an article on electric lines by E. Cadiat in the "Portefeuille Economique des Machines." As regards storage battery traction on the lines from St. Denis to the Madeleine and from the Opera to Neuilly the car-mileage aggregated, in 1893, 502,060, or 1,376 car-miles per day. The steam engines at St. Denis furnished for this service a total of 6,500 horse-power hours, or 4.72 horse-power hours per car-mile. M. Badois, who reported these figures, gives 2.75 lbs. of coal as the consumption per horse-power hour, and arrives at 12.98 lbs. of coal per car-mile. At Marseilles, during the first two weeks of operation of the trolley system, 150,348 lbs. of coal were consumed to run 19,970 car-miles, and during the second two weeks 150,975 lbs. for 18,983 car-miles. The average is 7.73 lbs., which, however, includes the coal used in connection with the lighting of the cars and the power station.

POWER TRANSMISSION.

HOW TO INSTALL AN ELECTRIC MOTOR FOR BLOWING CHURCH ORGANS.

BY S. H. SHARPSTEIN.

THE manufacturer of electric motors and the people installing them are quite frequently called upon to place small motors for blowing organs in churches, halls, houses, etc. After same consideration and figuring, the electrician or engineer finds that there are some problems about such plants that are not so very easily solved. A person conversant with the business will become thoroughly surprised at times to see what amateurs contrive in the way of belts, shafting, pulleys of all sizes and rheostats in order to try and pump an organ by electric motor.

When the problem of what apparatus to use and what methods to adopt to get the best results for the least money is left for the engineer, if he has got to choose between water from the street mains and a 220 or 500 volt power circuit, usually finds it no easy one to solve. In a case where a very low flat rate can be made for water, the rate to be assured for a number of years, the question is quite easily answered; but when the water has to be paid for by meter such power is very expensive as a rule. The piston water motor, when properly installed works admirably. Year by year sees water motors taken out and electric motors put in, as water companies insist on meters, and as the quality of the water is improved and the supply becomes scarce, as the towns and cities grow, the water rates go up as a rule. When electric power can be gotten by meter at a reasonable price per 1,000 watt hours, water by meter cannot compete. The electric motor being decided upon, then comes the question of efficiency, fire hazard, noise, durability, price and compactness. Everything must be made automatic, so as to need no attention for weeks at a time.

When the engineer considers some of the so-called perfect methods of pumping organs by electricity, and follows the path along which the power has to be transmitted, leading him through mammoth choking coils, shafting, and some belts traveling only 40 or 50 feet per minute at times, and he comes out with a net efficiency of only ½ of 1 per cent., he is filled with wonder at the perfection of the scheme. The matter of methods for a higher efficiency we will consider later.

The question of fire hazard is a vital one, since all about the motor—if placed in the room with the organ and bellows—are materials that will burn readily if once a fire is started; but if properly installed there is no danger from fire with an electric motor, even though it be in the room with the organ. It is quite a common thing to put the motor in a basement and let the pitman that operates the feeder bar extend down through the floor.

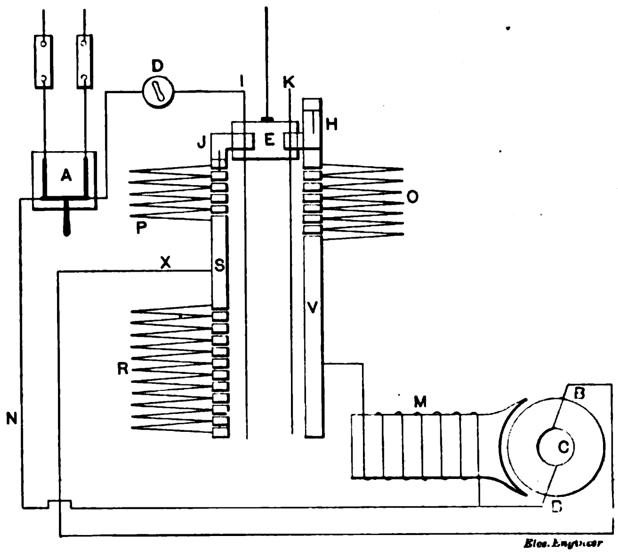
It is surprising to find how a small noise made by a motor will be amplified so as to be heard all over a hall or church. The writer has in mind a motor plant that was placed under a large church to blow a large organ. Four pieces of timber had been framed into the floor timbers directly under the organ, and projected down to a good masonry foundation. Upon these four sticks a good, substantial platform was built, about five feet from the ground, upon which the motor was placed. The motor was about 3-horse-power, and never made more than twelve hundred turns per minute. When started up, the hum of the iron in the armature could be heard all over the church. The armature was toothed, or iron-clad.

Although the commutator was very smooth, it was thought at first that the hum came from the brushes, but on changing to light copper brushes there was no difference that we could perceive. The organ-builder then placed a piece of rubber packing, about one-fourth of an inch thick, under the motor. Still there was most of the noise. There was a perceptible noise from the pitman, shafting and belts, that could be heard in the audience-room of the church and could not be heard in the basement. The audience-room floor was a mammoth sounding board, which carried the vibrations to every pew and up them to every portion of the room. It was thoroughly demonstrated then that all the trappings connected with the pumping machinery should be placed upon something independent of the audience-room floor.

A very short time after placing the motor mentioned above, the writer placed another in a pipe organ just back of the front pipes. The front of the organ was in a hall that was very high; the back of the organ was against a portion of the building that had two floors to the hall's one. Almost all of the organ was placed in the second story, which came part way up the length of the large pipes in the front of the organ. The motor stood on this second floor, about six feet back of the front pipes. This floor upon which the motor stood made a good sounding board, and the least noise could be heard in the hall. The commutator of the motor was greased, so that the brushes did not make any noise. The armature did not hum but a very little, as the machine was small; but a very little irregularity of the belt could be heard as it would strike the pulleys. It was necessary to take the motor out of the organ and place it in a back room; even now the least noise that the pitman may make can be heard very distinctly in the hall.

The question of durability is of vital importance. When once turned over to the purchasers the motor is not apt to get much care, unless some good organ-builder has charge of the organ. The bearings of the motor ought to be self-oiling, and the oil reservoirs ought to be large, so as to hold quite a quantity of oil. The brushes should be carbon, so as not to cut the commutator when not oiled or lubricated otherwise.

One source of great depreciation with some equipments for pumping organs has been the metal points, over which the contact piece keeps moving as the resistance in the rheostat is cut in and out by the bellows working up and down. At first thought it is realized that the speed at which the motor is to work at any one time is determined by the amount of wind the organ is using. When using the wind faster than the feeders are supplying it, the bellows will drop down, and this



METHOD OF CONTROLLING ORGAN BLOWING MOTORS.

lowering, together with the rising of the bellows, enables the engineer to get a point to start from in the regulation of the motor. The method of regulation that has been so much used has been a weight lying on top of the organ bellows. To this weight a string is attached running to a lever or directly to the arm on the resistance box. As the bellows lower, when a sudden demand is made for wind, the weight goes down with the bellows and pulls the lever on the resistance box in such a way as to cut resistance out of the armature circuit, which will have a tendency to make the motor run faster, and hence work the feeders faster to keep up with the demands of the performer at the keys. When less wind is used or the feeders commence sending too much wind into the bellows, the bellows rise up and by means of the string, lever, etc., cut the resistance in and slow up the motor. At the time the bellows get full, there is so much resistance in circuit with the armature that the motor stops, or very nearly so, depending on what is being done at the keys, or whether the organ is leaky or not, which would determine the bellows staying full for any length of time.

To the beginner this method seems all that could be desired, so he sets to work and makes a box with ample resistance in it to choke down the motor and puts about ten points on the face of the rheostat for movable contacts to pass over and puts the same close to the organ and gets it connected up. After some adjusting of lever and weight (right here we might say that a weight is used instead of putting a screw eye in the bellows to prevent pulling anything to pieces in case some lever or string might get fast and not want to move as the bellows go down, and many times it is not necessary to have the weight travel as far as the bellows) the thing is got working in pretty fair shape and all seems to be going on nicely; but the electrician in charge notices a small spark as the movable contact passes up and down over the fixed points.

Next day he comes to see how the thing is working and un-

derstands that the motor is doing all right and the equipment has had a good test since the builders have been very busy tuning ever since the thing was started. This sounds like good news, but as the electrician gets around and looks at the controller or resistance box, there seems to come a sort of serious look over his face. Even when there is nobody at the keys the bellows keep moving up and down some, and this moving of the bellows keeps the contact points on the rheostats sawing. As the movable piece leaves the stationary points the thing sparks four times as much as it did the day before. This is serious, the spark becoming so large that the people about the organ notice it and seem to be fearful that it will set something on fire.

After trying one thing and another, out comes the box, and about 70 or 80 stationary points go in the switch, and this makes the difference of potential so small between the bars that the sparking is stopped and all seems to go on well. The builders get the instrument tuned and then come the efforts of organists to empty the bellows with full organ; but the man who installed the motor is not afraid of that, since the motor is amply large and can do the work without any trouble. But the right man happens to get down at the organ and he plays along with most of the stops in for a time and uses so small an amount of wind that the motor and shafting is almost stopped. All at once he pulls out more stops and seems to make an effort to get down all the keys on the board; the music would have been grand, but before motor and gearing together with the feeders get started the bellows are empty and one great funny noise is made by the organ that tells the story of an empty bellows and some hustling feeders. The bellows had gone away down, the resistance was cut away out, and about the time that the bellows get empty the motor starts out on the emergency trot and the feeders punch the wind into the bellows so fast that the top of the bellows reminds one of the surface of the sea.

This thing is quite apt to occur, especially if the bellows are a little small for the organ and will not hold wind enough to supply the full organ for a short time. This method of regulation is not what it ought to be, for several reasons. Some one will say that he obviated the trouble just mentioned by having the resistance cut out very rapidly as the bellows start down, but if the rheostat is manipulated by hand and all cut out at once it takes little time to get things started if lots of shafting and pulleys are used, and by the time things are under way the bellows are empty.

Compactness is the last point we consider, but is by no means one that wants little attention. Architects seem to think that an organ can be squeezed into almost any kind of a corner, and as a rule the electric motor and its accessories have got to be put in a very small place.

We often see a motor installed to drive an organ when the motor is belted to a counter-shaft with one very large pulley and another one very small in diameter. From the pulley motor the belt runs onto the large pulley and this first belt has a proper speed. From the small pulley on the counter the second belt runs onto a pulley on the shaft that contains the crank that works the pitman. Since the speed of the pitman shaft is so slow, sometimes not over twenty turns per minute, it stands to reason that this second belt must have a very slow speed, even though there is a large pulley on the pitman shaft to have it run over. This arrangement is very cumbersome; it takes up much room and is bad in many respects, although so often used.

The writer has found the following arrangement compact and durable: On the shaft of the motor in place of a pulley put a worm to work into a gear, the worm and gear proportioned properly so that the shaft with the gear will make the proper number of revolutions for the crank and pitman. The inverted hangers to be used for supporting the crank shaft would be best if self-oiling, although the speed is so slow that very little lubricant is necessary if the bearings are large enough and made of good babbitt. The hangers will straddle the pulley end of the motor and if the motor and hangers are placed on a slate slab about two inches thick the whole arrangement is compact and complete. If the motor is to be placed where there must be the minimum of noise the worm and gear will probably have to be cased; but if not there is no reason why it will not run very nicely open or uncased.

An oil cup can be arranged so that when the motor is working, a lever worked by the magnetism of the fields will turn the oil on when the motor starts so as to keep the gear oiled. If the equipment is to get but very little care a small pan under the worm will hold oil and lubricate the thing very nicely. There should be a drip pan under the worm and gear anyhow, even if a cup is used. It is the work of a mechanic to get motor and bearings so arranged on the slab of slate that the whole thing will be stiff and work without noise. When compared with some of the old methods it will surprise a person to see how little space the whole thing, ready for the pitman, will take.

The question of end thrust will come up at once and seem to some to be quite a serious question, too; but if the end of the motor bearing next to the worm is well finished, a vulcanized fiber washer put between worm and bearing, and the worm left on a feather so as to move lengthwise on the shaft, the arrangement will be found to work nicely if the motor bearing is stiff as it should be on the pulley end. Persons not conversant with this work must bear in mind that the whole thing must be made solid and securely fastened to the floor or something similar, or it will hammer and chuck as the crank gets its up and down thrust.

The electrical part of the plant we will try to explain by the use of the accompanying diagram of circuits.

A is a double pole knife switch that should be in a convenient place and opened every time the organ is done with. This cuts the current off from the apparatus in all respects, which is demanded by the fire underwriters, and makes it very convenient when working around the motor.

From the right side of the switch one leg of the circuit leaves, and at D we will consider that we have placed a snap switch of either 500 or 220 volts, as the case may require. This switch must be on the front of the organ where the organist can reach it with ease and should be placed on a piece of slate to make it secure against fire. From this switch the circuit is run up and connected to brass bar I. On the two brass bars, I and K, runs a moderately heavy weight; cheap babbitt makes a good one. Onto this weight are fastened two brushes that travel on the compact columns, S and V.

When the organist is down at the organ and the switch, A, is closed by turning the switch, D, current passes into the metal weight, E, and from there into brush, H, thence down the segment bar, V, through the resistance, O, into the field of the motor, M, and back to the switch. This excites the fields of the motor ready for a start; at the same time the current passes into the other brush, F, through the resistance, P, and thence through wire, X, around through the armature and back to the main switch, A, through the wire, N. The resistance, P, acts as a starting box for the motor and as soon as the brush, F, passes down over the blocks, starts the motor nice and easy, and as soon as the brush, F, gets over this first lot of points the motor and organ feeders ought to have a speed that will furnish more wind than the organ can ever use, allowing quite a margin for leaks in the organ, which are sure to come sooner or later.

The organ builder is supposed to be able to tell the number of times per minute the feeders have got to be emptied to supply the organ with wind, but their estimates do not always hit the mark. The travel of the feeders, their size in square inches, together with the pressure per square inch inside the bellows will give the data that a person has got to work from to determine the amount of work to be done. Sometimes the feeders are wedge-shaped and work like a cover on a book; this adds to the complication of the matter, but with the help of a good organ builder a person can soon estimate the work to be done at the pitman.

To get back to our motor. The weight on the organ bellows attached to regulation wire or cord ought to be so arranged that soon after the brush, F, gets the resistance, P, cut out, the bellows should be three-fourths full, or this should take place before the brush, H, commences to cut out the resistance O. The resistance, O, ought to regulate the motor for all the ordinary work of the organ. This resistance changes the current flowing through the fields and makes the regulation very decided. If the motor is a two-horse-power machine it will always do two-horse-power work while being regulated through this resistance and will respond very quickly as the resistance is cut in or out.

People who have always worked with a resistance in the armature circuit for regulation will be surprised to see how quickly this arrangement will respond to any change in position of bellows so much different from the sluggish action of the motor with resistance in the armature circuit. And again, the amount of current passing through the field wires should be very small, hence high efficiency and no cutting from spark with a few points in the rheostat.

With the controlling resistance in the armature circuit more than double the energy is lost at times in the rheostat than is used in the motor. Some one who has been trying to build a slow speed, high efficiency motor by putting almost all the wire of the whole machine on the armature may say that the arrangement will not work, but a trial will tell the story. The people above mentioned will say that the motor will spark excessively with a weak field, but such is not necessarily the case. If the quantity of iron and wire are kept down in the armature and the fields properly wound the arrangement works very nicely. The motor has got to be quite slow speed

for a small one, but this can be arranged for by using a larger frame than is customary for the size of motor wanted. The resistance, R, will come in use when the organist has stopped playing for a short time, for tuning, etc., if the organ is in good condition and does not leak much. Switch F, cuts this resistance into the circuit with the armature when the bellows get full to the extreme capacity; it ought to stop the motor still if necessary.

It is very convenient to have the starting coils in the iron box with the other coils, but the organist must understand never to commence to play a piece of music that will take much wind until the bellows get time to fill. With the average organ all the resistance wire except the starting coils can be very fine. Since so little current is manipulated in controlling the arrangement there is not much heat to be gotten rid of, hence all can be placed in a small iron box properly ventilated and an iron cover put on. This should suit the most exacting of the examiners for the board of fire underwriters. A piece of slate should be placed between the controlling box and the floor, or any support that the box may be fastened to.

THE SUSQUEHANNA POWER PLANT.

Plans for the construction of the great electric plant, by which the Susquehanna River will be used to furnish electrical power to towns in Maryland and along the Susquehanna in Pennsylvania, and also points in Delaware, have been completed by Clemens Herschel, of New York, the hydraulic engineer, who had charge of the hydraulic construction of the Niagara plant. Work will be begun in the early spring, and in less than a year's time the company expects to be able to furnish power as far north as Wilmington, Del., and as far south as Baltimore. At two falls it is proposed to develop 40,000 horse-power each, and the minimum flow of the Susquehanna River, which is only about 2 per cent. of the time, produces 25,000 horse-power at each fall. The company has acquired most of the land fronting on the Susquehanna River between Conowingo, Md., and the Pennsylvania state line. A great dam and a system of canals will be constructed, in which will be placed the penstocks and turbine wheels for generating the electricity, the whole plan being similar to the Niagara Falls system. Outside of Niagara, the Susquehanna River is the largest Eastern water power near a large city.

POWER TRANSMISSION PLANT FOR COLUMBIA, S. C.

The contract for the construction of the Granby Power House has been awarded to Messrs. W. A. Chapman & Co., the firm which built the Columbia Mills. The power house will be built between the Congaree River Bridge and the power house which is used to furnish electric power for the Columbia Mills. The building will be 184 feet long by 65 feet deep and will have a stone foundation.

Ten thousand horse-power will be generated from the building which will be sufficient to run twenty cotton factories of the ordinary size. To get some idea of the amount necessary to run a mill, the Columbia Mills may be taken as an example where 1,500 horse-power is now used, but in June this will be doubled. Five hundred horse-power will run a mill with 80,000 spindles.

Enough power power can be generated to run all the mills that can be built on the canal, besides being sufficient to light the entire city and furnish motive power for the electric cars.

WOODEN POLES FOR THE NIAGARA BUFFALO TRANSMISSION.

The contract for furnishing 2,000 wooden poles for the power transmission line to Buffalo has been let by the Cataract Construction Company to Thomas Barnard, of Lockport. Mr. Barnard is connected with the construction department of the Western Union Telegraph Company, and has an office in Buffalo.

LIGHT FROM ARTESIAN WELL POWER.

The large artesian well recently sunk at Chamberlain, S. D., is now at work running the electric light and power plant in that town. The water is utilized through a three-inch nozzle, playing upon a Pelton water wheel. The present plant supplies 275 32-candle-power incandescent lamps, but there is sufficient reserve power to run double this number.

CROSSING LIGHTS AT SHERMAN, TEXAS.—The Department of Public Works has been instructed by the Board of Aldermen to cause the railroads to erect and maintain electric street lamps at several street crossings, said lamps to not be of less than 2,000 candle-power each.

ELECTRIC LIGHTING.

ON RADIANT MATTER.—II.

BY WILLIAM CROOKES, F.R.S.

The spectrum of the red light emitted by these varieties of alumina is the same as described by Becquerel twenty years ago. There is one intense red line, a little below the fixed line B in the spectrum, having a wave-length of about 6,895. There is a continuous spectrum beginning at about B, and a few fainter lines beyond it, but they are so faint in comparison with this red line that they may be neglected. This line is easily seen by examining with a small pocket spectroscope the light reflected from a good ruby.

There is one particular degree of exhaustion more favorable that any other for the development of the properties of radiant matter which are now under examination. Roughly speaking, it may be put at the millionth of an atmosphere.[4] At this degree of exhaustion the phosphorescence is very strong, and after that it begins to diminish until the spark refuses to pass.[5]

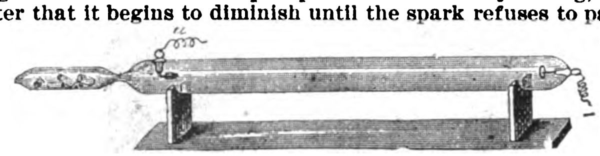


FIG. 5.

I have here a tube (Fig. 5) which will serve to illustrate the dependence of the phosphorescence of the glass on the degree of exhaustion. The two poles are at a and b, and at the end c is a small supplementary tube, connected with the other by a narrow aperture, and containing solid caustic potash. The tube has been exhausted to a very high point, and the potash heated so as to drive off moisture and injure the vacuum. Exhaustion has then been recommenced, and the alternate heating and exhaustion repeated until the tube has been brought to the state in which it now appears before you. When the induction spark is first turned on nothing is visible—the vacuum is so high that the tube is non-conducting. I now warm the potash slightly and liberate a trace of aqueous vapor. Instantly conduction commences, and the green phosphorescence flashes out along the length of the tube. I continue the heat, so as to drive off more gas from the potash. The green gets fainter, and now a wave of cloudy luminosity sweeps over the tube, and stratifications appear, which rapidly get narrower, until the spark passes along the tube in the form of a narrow purple line. I take the lamp away, and allow the potash to cool; as it cools, the aqueous vapor, which

[4]1.0 millionth of an atmosphere equals 0.00076 mm.; 1315.789 millionths of an atmosphere equal 1.0 mm.; 1,000,000 millionths of an atmosphere equal 760.0 mm.; 1,000,000 millionths of an atmosphere equal 1 atmosphere.

[5]Nearly a hundred years ago, Mr. William Morgan communicated to the Royal Society a paper entitled "Electrical Experiments made to ascertain the Non-conducting Power of a Perfect Vacuum," etc. The following extracts from this paper, which was published in the "Philosophical Transactions" for 1785 (vol. lxxv., p. 272), will be read with interest:

A mercurial gage about fifteen inches long, carefully and accurately boiled till every particle of air was expelled from the inside, was coated with tin-foil five inches down from its sealed end, and being inverted into mercury through a perforation in the brass cap which covered the mouth of the cistern, the whole was cemented together, and the air was exhausted from the inside of the cistern, through a valve in the brass cap, which, producing a perfect vacuum in the gage, formed an instrument peculiarly well adapted for experiments of this kind. Things being thus adjusted (a small wire having been previously fixed on the inside of the cistern to form a communication between the brass cap and the mercury, into which the gage was inverted), the coated end was applied to the conductor of an electrical machine, and, notwithstanding every effort, neither the smallest ray of light nor the slightest charge could ever be procured in this exhausted gage.

If the mercury in the gage be imperfectly boiled, the experiment will not succeed; but the color of the electric light, which in air rarefied by an exhauster is always violet or purple, appears in this case of a beautiful green, and, what is very curious, the degree of the air's rarefaction may be nearly determined by this means; for I have known instances, during the course of these experiments, where a small particle of air having found its way into the tube, the electric light became visible, and as usual of a green color; but the charge being often repeated, the gage has at length cracked as its sealed end, and in consequence the external air, by being admitted into the inside, has gradually produced a change in the electric light from green to blue, from blue to indigo, and so on to violet and purple till the medium has at length become so dense as no longer to be a conductor of electricity. I think there can be little doubt, from the above experiments, of the non-conducting power of a perfect vacuum.

This seems to prove that there is a limit even in the rarefaction of air, which sets bounds to its conducting power; or, in other words, that the particles of air may be so far separated from each other as no longer to be able to transmit the electric fluid; that if they are brought within a certain distance of each other, their conducting power begins, and continually increases till their approach also arrives at its limit.

the heat had driven off, is reabsorbed. The purple line broadens out, and breaks up into fine stratifications; these get wider, and travel toward the potash tube. Now a wave of green light appears on the glass at the other end, sweeping on and driving the last pale stratification into the potash; and now the tube glows over its whole length with the green phosphorescence. I might keep it before you, and show the green growing fainter and the vacuum becoming non-conducting;

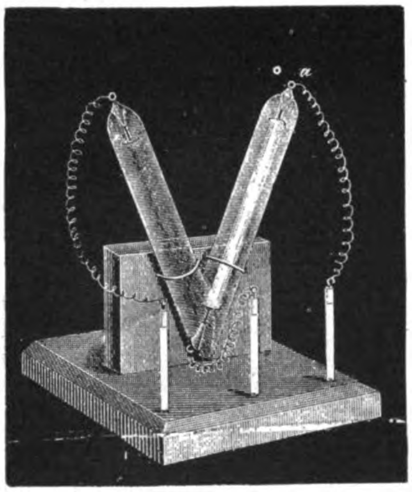


FIG. 6.

but I should detain you too long, as time is required for the absorption of the last traces of vapor by the potash, and I must pass on to the next subject.

RADIANT MATTER PROCEEDS IN STRAIGHT LINES.—The radiant matter whose impact on the glass causes an evolution of light, absolutely refuses to turn a corner. Here is a V-shaped tube (Fig. 6), a pole being at each extremity. The pole at the right side (a) being negative, you see that the whole of the right arm is flooded with green light, but at the bottom it stops sharply and will not turn the corner to get into the left side. When I reverse the current and make the left pole negative, the green changes to the left side, always following the negative pole and leaving the positive side with scarcely any luminosity.

In the ordinary phenomena exhibited by vacuum tubes—phenomena with which we are all familiar—it is customary, in order to bring out the striking contrasts of color, to bend the tubes into very elaborate designs. The luminosity caused by the phosphorescence of the residual gas follows all the convolutions into which skillful glass-blowers can manage to twist the glass. The negative pole being at one end and the

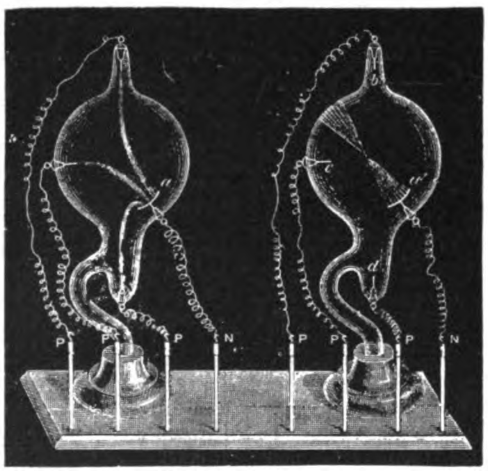


FIG. 7.

positive pole at the other, the luminous phenomena seem to depend more on the positive than on the negative at the ordinary exhaustion hitherto used to get the best phenomena of vacuum-tubes. But at a very high exhaustion the phenomena noticed in ordinary vacuum tubes when the induction-spark passes through them—an appearance of cloudy luminosity and of stratifications—disappear entirely. No cloud or fog whatever is seen in the body of the tube, and with such a vacuum as I am working with in these experiments, the only light observed is that from the phosphorescent surface of the glass. I have here two bulbs (Fig. 7), alike in shape and position of poles, the only difference being that one is at an exhaustion equal to a few millimetres of mercury—such a moderate exhaustion as will give the ordinary luminous phenomena—while the other is exhausted to about the millionth of an atmosphere. I will first connect the moderately exhausted bulb (A) with the induction-coil, and retaining the pole at one side (a) always negative, I will put the positive wire successively to the other poles with which the bulb is furnished. You see that as I change the position of the positive pole, the line of violet light joining the two poles changes, the electric current always choosing the shortest path between the two poles, and moving about the bulb as I alter the position of the wires.

This, then, is the kind of phenomenon we get in ordinary exhaustions. I will now try the same experiment with a bulb (B) that is very highly exhausted, and, as before, will make the side pole (a') the negative, the top pole (b) being positive. Notice how widely different is the appearance from that shown by the last bulb. The negative pole is in the form of a shallow cup. The molecular rays from the cup cross in the center of the bulb, and thence diverging fall on the opposite side and produce a circular patch of green, phosphorescent light. As I turn the bulb round you will all be able to see the green patch on the glass. Now, observe, I remove the positive wire from the top, and connect it with the side pole (c). The green patch from the divergent negative focus is there still. I now make the lowest pole (d) positive, and the green patch remains where it was at first, unchanged in position or intensity.

We have here another property of radiant matter. In the low vacuum the position of the positive pole is of every importance, while in a high vacuum the position of the positive

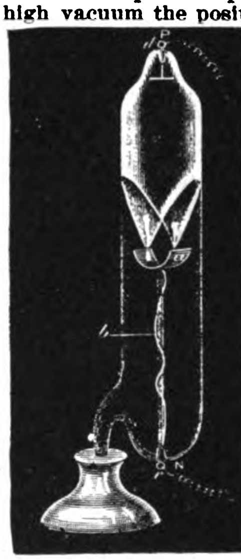


FIG. 8.

pole scarcely matters at all; the phenomena seem to depend entirely on the negative pole. If the negative pole points in the direction of the positive, all very well, but if the negative pole is entirely in the opposite direction it is of little consequence; the radiant matter darts all the same in a straight line from the negative.

If, instead of a flat disk, a hemi-cylinder is used for the negative pole, the matter still radiates normal to its surface. The tube before you (Fig. 8) illustrates this property. It contains, as a negative pole, a hemi-cylinder (a) of polished aluminum. This is connected with a fine copper wire (b), ending at the platinum terminal (c). At the upper end of the tube is another terminal (d). The induction-coil is connected so that the hemi-cylinder is negative and the upper pole positive, and when exhausted to a sufficient extent the projection of the molecular rays to a focus is very beautifully shown. The rays of matter being driven from the hemi-cylinder in a direction normal to its surface, come to a focus and then diverge, tracing their path in brilliant green phosphorescence on the surface of the glass.

Instead of receiving the molecular rays on the glass, I will show you another tube in which the focus falls on a phosphorescent screen. See how brilliantly the lines of discharge shine out, and how intensely the focal point is illuminated, lighting up the table.

NEW EXPERIMENTS ON THE CATHODE RAYS.[1]

TWO hypotheses have been propounded to explain the properties of the cathode rays.

Some physicists think with Goldstein, Hertz and Lenard, that this phenomenon is like light, due to vibrations of the ether,[2] or even that it is light of short wave-length. It is easily understood that such rays may have a rectilinear path, excite phosphorescence, and affect photographic plates.

Others think, with Crookes and J. J. Thomson, that these rays are formed by matter which is negatively charged and moving with great velocity, and on this hypothesis their mechanical properties, as well as the manner in which they become curved in a magnetic field, are readily explicable.

This latter hypothesis has suggested to me some experiments which I will now briefly describe, without for the moment pausing to inquire whether the hypothesis suffices to explain all the facts at present known, and whether it is the only hypothesis that can do so. Its adherents suppose that the cathode rays are negatively charged; so far as I know, this electrification has not been established, and I first attempted to determine whether it exists or not.

(2) For that purpose I had recourse to the laws of induction, by means of which it is possible to detect the introduction of electric charges into the interior of a closed electric conductor, and to measure them. I therefore caused the cathode rays to pass into a Faraday's cylinder. For this purpose I employed the vacuum tube represented in Fig. 1. A B C D is a tube with an opening (a) in the center of the face B C. It is this tube which plays the part of a Faraday's cylinder. A metal thread soldered at S to the wall of the tube connects this cylinder with an electroscope.

E F G H is a second cylinder in permanent communication with the earth, and pierced by two small openings at β and γ; it protects the Faraday's cylinder from all external influence. Finally, at a distance of about 0.10 m. in front of F G, was placed an electrode N. The electrode N served as cathode; the anode was formed by the protecting cylinder E F G H; thus a pencil of cathode rays passed into the Faraday's cylinder. The cylinder invariably became charged with negative electricity.

The vacuum tube could be placed between the poles of an electro-magnet. When this was excited, the cathode rays, becoming deflected, no longer passed into the Faraday's cylinder, and this cylinder was then not charged; it, however, became charged immediately the electro-magnet ceased to be excited.

In short, the Faraday's cylinder became negatively charged when the cathode rays entered it, and only when they entered it; the cathode rays are then charged with negative electricity.

The quantity of electricity which these rays carry can be measured. I have not finished this investigation, but I shall give an idea of the order of magnitude of the charges obtained when I say that for one of my tubes, at a pressure of 20 microns of mercury, and for a single interruption of the primary of the coil, the Faraday's cylinder received a charge of electricity sufficient to raise a capacity of 600 C. G. S. units to 300 volts.

(3) The cathode rays being negatively charged, the principle of the conservation of electricity drives us to seek somewhere the corresponding positive charges. I believe that I have found them in the very region where the cathode rays are formed, and that I have established the fact that they travel in the opposite direction, and fall upon the cathode. In order to verify this hypothesis, it is sufficient to use a hollow cathode pierced with a small opening by which a portion of the attracted positive electricity might enter. This electricity could then act upon a Faraday's cylinder inside the cathode.

The protecting cylinder E F G H with its opening β fulfilled these conditions, and this time I therefore employed it as the cathode, the electrode N being the anode. The Faraday's cylinder is then invariably charged with positive electricity. The positive charges were of the order of magnitude of the negative charges previously obtained.

Thus, at the same time as negative electricity is radiated from the cathode, positive electricity travels towards that cathode.

I endeavored to determine whether this positive flux formed a second system of rays absolutely symmetrical to the first.

(4) For that purpose I constructed a tube (Fig. 2) similar to the preceding, except that between the Faraday's cylinder and the opening β was placed a metal diaphragm pierced with an opening β' so that the positive electricity which entered by β could only affect the Faraday's cylinder if it also traversed the diaphragm β'. Then I repeated the preceding experiments.

When N was the cathode, the rays emitted from the cathode passed through the two openings β and β without difficulty, and caused a strong divergence of the leaves of the electroscope. But when the protecting cylinder was the cathode, the positive flux, which, according to the preceding experiment, entered at *B* did not succeed in separating the gold leaves except at very low pressures. When an electrometer was substituted for the electroscope it was found that the action of the positive flux was real but very feeble, and increased as the pressure decreased. In a series of experiments at a pressure of 20 microns, it raised a capacity of 2,000 C. G. S. to 10 volts; and at a pressure of 3 microns, during the same time, it raised the potential to 60 volts.[3]

By means of a magnet this action could be entirely suppressed.

(5) These results as a whole do not appear capable of being easily reconciled with the theory which regards the cathode rays as an ultra-violet light. On the other hand they agree well with the theory which regards them as a material radiation, and which, as it appears to me, might be thus enunciated.

In the neighborhood of the cathode, the electric field is sufficiently intense to break into pieces (into ions) certain of the molecules of the residual gas. The negative ions move towards the region where the potential is increasing, acquire a considerable speed, and form the cathode rays; their electric charge, and consequently their mass (at the rate of one valence-gramme for 100,000 Coulombs) is easily measurable. The positive ions move in the opposite direction; they form a diffused brush, sensitive to the magnet, and not a radiation in the correct sense of the word.

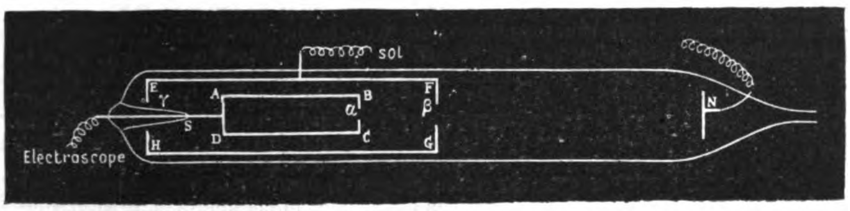


FIG. 1.

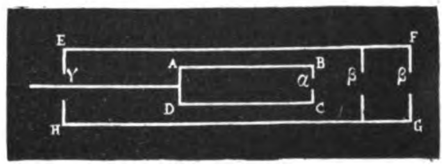


FIG. 2.

A 6,000-VOLT MEETING.

A 6,000-volt meeting of the directors was held at the Nelson Electric Light Company's power house yesterday, says the Juneau (Alaska) "Morning Record." The current became so strong at one time that two temper switches burned out with a flash of blue flame and it was found necessary to shut off the circuit with a shovel. Some important move must be contemplated, as two directors were observed going to bank very hurriedly.

AN EDDY PLANT AT BANGOR, ME.

J. N. V. Lane, the Bangor electrician, is now completing an important contract, the installation of a private lighting plant for the large woodworking establishment of Morse & Co., on Valley avenue, this city. The plant is entirely separate from the other machinery of the mill, the dynamo, a 300-light direct current "Eddy," manufactured by the Eddy Electric Manufacturing Company of Windsor, Conn., being run by a separate engine. Mr. Lane has connected 200 lights throughout the mills, under control of a slate swichboard. The plant works admirably.

[1] Translation of a paper by M. Jean Perrin, read before the Paris Academy of Sciences on Dec. 30, 1895.

[2] These vibrations might be something different from light; recently M. Jaumann, whose hypotheses have since been criticised by M. H. Poincaré, supposed them to be longitudinal.

[3] The breaking of the tube has temporarily prevented me from studying the phenomenon at low temperatures.

[4] This work has been carried out in the laboratory of the Normal School, and in that of M. Pellat, at the Sorbonne.

ON THE PRESENT HYPOTHESES CONCERNING THE NATURE OF ROENTGEN'S RAYS.[1]

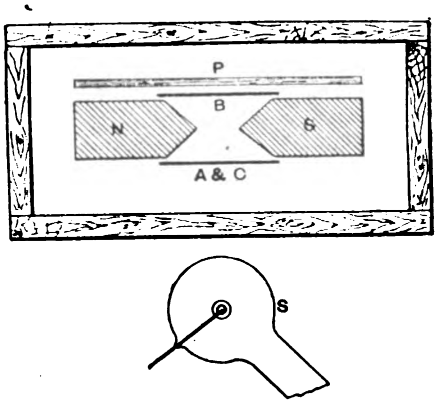
BY DR. OLIVER LODGE, F.R.S.

Until recently I was still uncertain whether Röntgen rays might not experience a trace of deflection in a strong magnetic field; and this, notwithstanding the assertion of the discoverer that he had found no deflection. No details of the experiment had been given, and although it might seem safe to trust the bare assertion of so known an experimenter as Professor Röntgen, yet, on account of the portentous gravity of the issue, I felt bound to satisfy myself by a direct confirmatory experiment. If only there were a magnetic deflection of the rays, the very simplest of all possible hypotheses would be confirmed—the hypothesis, viz., of a kind of sound-pulse conveyed by electrified particles, streaming on the whole in one direction, with interchanges of energy, passing on the motion in a Grotthüs-chain kind of fashion, but passing it on by simple material impact; a kind of electrolytic radiation, as I have expressed it.

My first experiment on magnetic deflection, the shadowgraph of a magnet with a background of wire-gauze, only showed that if there were any shift by reason of passage of rays between the poles it was very small; but I have now definitely to assert that a further experiment has been made which effectually removes the idea of deflectibility from my mind, and confirms the statement of Professor Röntgen.

A strong though small electromagnet, with concentrated field, had a photograph of its pole-pieces taken with a couple of wires, A and C, stretched across them on the further side from the plate—nearer the source—and a third wire B also stretched across them, but on the side close to the plate. (See Figure.) These three wires left shadows on the plate, of which B was sharp and definite, while A and C were blurred.

A couple of radiographs were taken by Mr. Robinson, one with the magnet on, and one with the magnet reversed. On subsequently superposing the two plates, with the sharp shadows of B coincident, the very slightest displacement of shadows A and C could have been observed, although those shadows were not sharp. But there was absolutely no perceptible displacement, the fit was perfect. Consequently the hypothesis of a stream of electrified particles is definitely disproved; as no doubt had already been effectively done in reality by Professor Röntgen himself.



But it must be noted that the hypothesis of a simple molecular stream—not an electrified one—remains a possibility. The only question is whether such an unelectrified bombardment would be able to produce the observed effects. In so far as it could affect photographic plates one would suppose it must be by means of phosphorescence, but it is doubtful whether it would even have the power of exciting phosphorescence.

It must be remembered that Dr. Lenard found among his rays two classes as regards deflectibility—some much deflected, others less deflected; and it must be clearly understood that his deflections were observed, not in the originating vacuum tube, where the fact of deflection is a commonplace, but outside, after the rays had been as it were "filtered" through an aluminum window. He did not, indeed, observe the deflection in air of ordinary density, it was in moderately rarefied air that he observed it, but he showed that the variation of air density did not affect the amount, but only the clearness of the minimum magnetic deflection. The circumstance that affected the amount of the deflection was a variation in the contents of the originating or high-vacuum tube.

The hypothesis, therefore, that naturally suggests itself is that the highly-charged particles flying from the cathode deliver up the greater part of their charges when they reach the aluminum window, and that the outside particles which take up the running are less charged, some of them perhaps not charged at all. These last would not be so likely to excite phosphorescence, hence Lenard would not perceive them; he would only observe those that had managed to retain or acquire a modicum of charge, and these would be deflected.

The question has still to be asked, therefore, whether the rays discovered by Professor Röntgen, which are not at all deflected, are those which possess no trace of charge.

Besides, it must be remembered that the absence of deflection has only been proved in ordinary air, while the presence of magnetic deflection has only been proved in somewhat rarefied air; the investigation into this matter is not finished until a further experiment is done—viz., to verify the non-deflectibility of the Röntgen rays even in a fairly good vacuum.

So much for what remains of the almost defunct radiant-matter hypothesis (defunct only, be it understood, for the particular kind of rays studied by Professor Röntgen; and not really defunct for them, but in a state of suspended animation. The hypothesis of a bombardment of uncharged particles I have by no means yet abandoned).

The alternative hypothesis, as generally conceived, is some form of waves. True, no absolute necessity has been yet made out for a periodic disturbance traveling at a finite speed; but the circumstance that fluorescent materials are excited, and chemical action precipitated, suggests a periodic motion not altogether out of time with the vibration-frequency of molecules.

Let us grant, then, that this circumstance renders it likely that the cause of the Röntgen effects is to be sought in some kind of wave-disturbance in the ether. The next question that arises is, Is it of the nature of etherial light or of etherial sound? Is it such transverse or electrical vibrations as are obedient to the equations of Maxwell, or is it a mode of longitudinal disturbance requiring some generalization or modification of those equations in order to express it?

On the principle that we are bound to apply the simplest hypothesis until it can be shown to be insufficient, it is necessary to consider how far the hypothesis of transverse or electrical vibrations can be made to serve. The chief difficulty here is the transparency of electrical conductors. To Maxwell's waves, i. e., the light of every kind, they ought to be opaque. But already the translucency of gold leaf has been a slight known difficulty in the same direction, and it has been shown that by postulating interstices or lack of homogeneity, i. e., a structure not infinitely fine-grained with respect to the size of light waves, the difficulty can be more or less satisfactorily overcome. Why not, then, assume that these new waves are much smaller than any hitherto known? Why not assume that they compare closely in size with the atoms themselves? Indeed, if they compare in frequency, they must compare also in size if they are transverse waves, for the only pace at which such waves can travel through the ether is accurately known. That there is plenty to be said for this hypothesis is obvious from the fact that it appears to commend itself both to Professor Schuster and to Professor Fitzgerald. Among other things that can be said in favor of it are the following: Electrical oscillations in conductors are known to have the power of exciting light-waves, hence light-waves may be expected from electric oscillations or surgings in atoms; but visible waves are not so excited. Visible light appears to be due to something more like the sound-vibration of atoms, as if they were bells or plates struck and made to vibrate. Bells and plates of atomic size would vibrate at about the required pace, viz., 400 to 800 million vibrations per second.

But electrical or Hertz-like oscillations of a charge on conductors of atomic size would vibrate immensely faster, being controlled not by the rate at which sound travels across an atom, but by the rate at which light travels, and this is just about 100,000 times as quick. Hence, as has often been pointed out, electrical oscillations in atoms are too quick for light; but yet they must occur, one would think, when atoms are being violently disturbed and charged and discharged; and if ever such oscillations occur, transverse waves must be emitted. Why should not these constitute the Röntgen rays?

This matter of the extra-rapid ultra-ultra-violet light may be safely left in the hands of its supporters. Its great advantage is that it utilizes no new or unknown property of the ether—nay, more, it utilizes a disturbance which, although not yet otherwise discovered, must naturally be assumed to exist, unless definite reason is shown against it. It is needless to emphasize further the high probabilities in favor of this hypothesis. Such statements as there are against it will follow incidentally.

Now we come to the last hypothesis, the one suggested by Professor Röntgen—the one which commands the high support of Professor Boltzmann—the one which it is not too rash

[1] London "Electrician."

to assume is regarded not unfavorably by Lord Kelvin,[1]—viz., the hypothesis of etherial sound or longitudinal waves in the ether. The only facts hitherto assumed to utilize longitudinal or pull-and-push properties in the ether are the facts of gravitation and of cohesion. Newton himself showed that an etherial tension or pressure would account for gravitation. Nothing is known about these properties, and there are difficulties in supposing that the ultimate space-filling medium can be really compressible. It is not, indeed, necessarily compressible to account for cohesion and gravitation, but it must either be compressible, or else simulate the effects of compressibility, if it is to transmit a periodic or atom-shaking disturbance at any finite pace.

Assume for the moment a slight compressibility of some sort, and consider what occurrences there are in a well-exhausted vacuum tube which could start longitudinal waves in such a medium. We have in the vacuum tube a violent torrent of atoms striking on the glass. Suppose that the vacuum is about 10^{-6} of an atmosphere—which appears to be something like that needed to give good effects—then the distance apart of the residual atoms in the exhausted space is a hundred times as great as in ordinary air, and a thousand times as great as in liquids; hence the distance will be about 10^{-5} cm.; or each spot of glass will receive a hundred thousand blows from every centimeter length of the stream to which it is subjected. But the speed of the cathode rays has been directly measured by J. J. Thomson as something comparable to 10^7 cm. per second. Hence the glass will be struck on the average, at every point, 10^{12} or a billion times a second, by the mere procession of negatively-charged atoms. It is easy for this estimate to err by a factor 10, and it is also easy for places to be sometimes struck ten times more frequently, by reason of the above estimate being only an average. Hence it may be surmised that the frequency of luminous vibrations is occasionally reached, and the glass not only grows hot but also shines.

It is probably quite unnecessary to appeal to this rapidity of bombardment in order to account for visible fluorescence, but the rapidity of bombardment is of interest because in any compressible medium such rudely periodic disturbances could hardly help starting some kind of sound waves.

But, besides that, the atoms themselves are known to be elastic, and to have definite periods of vibration like plates or bells, as evidenced by their spectroscopic lines; hence the blows to which they are subjected must be thought of as likely to excite vibrations or crispations in them. The frequency of these are such as to emit luminous waves in an ether possessing electromagnetic properties, the atoms being charged; but if they occur in an ether which is anything like a compressible fluid, how can they avoid exciting mechanical or sound waves too?

Nothing can be known for certain about the wave-length or velocity of such waves in ether until an interference or diffraction experiment has been performed, but the order of magnitude of the frequency can be taken as that of light, say 10^{15} per second, or quicker. The only way at present to gather some idea of the wave length is to attend, (a) to the sharpness of the shadows, (b) to the thickness of medium which is effectively opaque.

The longer the wave the more transparent are things likely to be, because waves are always damped out logarithmically, and this needs a certain number of swings, or at least a certain fraction of a swing, for notable damping to occur. A wave a yard long is not likely to be effectively stopped by an obstacle an inch thick. Without a knowledge of the damping-ratio, however, no numerical estimate can so be made, but a better estimate can be got from the sharpness of shadows. Take a point source, and investigate the outline of the shadow of an object held at a moderate distance from the screen or sensitive plate. No clear shadow will be thrown when the size of the obstacle is comparable to a wave length, if its size is small, or when it is removed several wave lengths from the plate, if the size of the obstacle is large. For, in wave theory, shadows are thrown by interference; and diffraction effects become prominent even when a want of precision about the source hinders the recognition of any clear diffraction pattern. The latter would not only indicate the wave length, but measure it. Short of that an estimate can be hoped for. Mr. A. W. Porter, in Professor Carey Foster's laboratory, has obtained the sharpest radiographs I have yet seen, and he has the best chance of getting the data for an estimate. Suppose for the moment we guess that a wave length of about 1c m. is not unlikely, then the speed of the hypothetical longitudinal waves would be of the order 10^{15} cm. per second, or more, i. e., about as much quicker than light as light is quicker than sound.

Such waves if they existed might be reasonably styled gravitational waves; for although gravitation does not need any wave propagation, only a state of statical stress or tension, yet it would be the rate at which the tension traveled outward if a fresh piece of matter started existence, or probably if an old piece of mater moved about with sufficient rapidity. Such motion would appear likely to entail aberrational effects, but aberrational questions are notoriously difficult, and the subject is only here mentioned because it is doubtful whether the Laplacian difficulty would be felt in astronomy if gravitation traveled a million times as quick as light. The pull of the sun would be felt in the time that light needs to travel 92 miles, and this is nearly instantaneous; or, otherwise, the terrestrial aberration-angle for gravity would be only the hundred-thousandth part of a second of arc.

But what about the Cavendish-Faraday-Maxwell experiment? that experiment which is held to establish the incompressibility of the ether, or the electrostatic law of inverse square, or the impossibility of a free or isolated electric charge (see "Modern Views of Electricity," Second Edition, pp. 9, 11, 29, 31-34, 257). We cannot tell what the volume-elasticity of the ether has to be, in order to transmit condensational waves of the above speed, unless we know its density. Dr. Larmor has shown some reason for supposing that ether may be as dense as platinum. If it be anything like that, and if the longitudinal wave velocity is 10^{18}, then the incompressibility is more than 10^{30} C. G. S. units; too great for any such experiment to show.

The object of mentioning these matters here is to help to realize that there is nothing in present knowledge obviously fatal to the idea of longitudinal waves in the ether; but the arguments in their favor, in connection with Röntgen rays, remain to be given. Assuming wave propagation of some kind, every argument against tranverse is in favor of longitudinal, and vice versa.

Now the thing that suggested longitudinal waves to Röntgen was the fact that crystalline properties were of no importance: e. g., that Iceland spar and quartz were equally transparent or opaque whichever way you turn them. But it must be admitted that such a test as that is next door to none. If tourmaline is transparent to Röntgen rays going along its axis it would be a much better test; and this I have myself ascertained to be the fact. J. J. Thomson also has found that a pair of ordinary cut tourmalines are equally transparent whether their axes are "crossed" or parallel; which is an excellent test. Nothing suggestive of polarization in any form has yet been observed; a fact which tends against transverse and in favor of longitudinal waves. But the strongest argument in favor of longitudinal waves is derivable from the fact that the rays discharge electrified bodies. Lenard found this, and J. J. Thomson and I have both obtained it easily under Röntgen-like conditions; but their peculiarity is that (unlike light) they discharge positive and negative about equally.

Now, Elster and Geitel showed that when polarized light discharges a really smooth surface it is most effective when the electric oscillation is partly normal, not tangential, to the surface; in other words, that it is what may be called the longitudinal or end-on component of ordinary light that is by far the most effective in discharging electricity.

Mr. Robinson thinks he has observed that the same thing is true as regards the power of exciting fluorescence; an important observation if true, but the examination is not complete yet. If it turns out so, then the two things that Röntgen rays are known to do are characteristic of end-on or normal vibrations.

As to the photographic or radiographic action, it is so slow and inadequate at present that it hardly looks like a direct primary effect, but even there it seems as if thick films did better than thin.

Another fact that gives a gravitational look to Röntgen's rays is the fact that they appear to pay more attention to specific gravity or ordinary density than to any other property of matter. This can be said without stating that opacity and density are strictly proportional. Any way, electrical properties of matter seem to be quite unimportant; polish or roughness, a coherent block or a powdered mass, are all the same to these waves, as they are to gravity.

Direction of crystallization matters nothing, nor does shape; an aluminum prism cannot bend them; they cannot be bent or even reflected to any considerable extent. If it be found that physical state is also unimportant, so that the same molecules obstruct equally however they be aggregated, whether

[1]In this connection it is interesting to refer to Lord Kelvin's Presidential Address to the Royal Society, Nov. 30, 1893 (Harrison & Son, London), on the subject of Hertz-waves and Radiant Matter, in which he confidently anticipates further progress and gives an interesting résumé of the history of highly exhausted vacuum-tube effects in connection with the subject. He emphasizes the important part played by Cromwell Varley in 1871, before either Bittorf or Crookes, in the discovery of cathode rays and strongly supports the material view, in opposition to many continental workers.

into solid, liquid or gas, that will be a further contribution to the evidence in the same direction.

Thus there is plenty of scope for experiment. A few weeks may be sufficient to intensify our conviction in one or other of the already-mentioned directions, or we may find ourselves urged by new facts in some other direction not yet thought of.

In conclusion, let it be remembered that Lenard, Hertz, Goldstein and the Germans generally (except Helmholtz—a notable exception!) have consistently urged that cathode rays were something more than a stream of particles; in case it should so turn out, Lenard urged this for his rays outside, in air. Hertz, I believe, urged it for the rays inside the vacuum. It may be that the streaming particles are there, but an ethereal process may be also there. Outside in the Lenard rays both processes possibly coexist, one deflectible by a magnet, the other not. That both processes exist also inside the vacuum is not likely. J. J. Thomson has exposed a protected plate in the very rays themselves inside the vacuum and got no result. It looks as if the streaming particles alone could not achieve it.

If the sun emits any rays that can reach photographic plates through boxes or hand bags, even through black paper, every touring photographer should know; but if cathode rays alone have no direct action, without the intervention of a phosphorescent substance, then even the absence of direct solar action would constitute no valid and conclusive proof that the coronal rays are not electrical, though it would very much militate against a method of easily obtaining a photographic record of the corona which has been suggested.

ROENTGEN RAYS DISSIPATE ELECTRIC CHARGES.

The following letter from Professor J. J. Thomson appears in the London "Electrician" of Feb. 7, 1896: "Those of your readers who are making experiments on Röntgen's rays may perhaps be interested in a method of testing their presence which is more delicate and expeditious than a photographic plate, and also more easily adapted to quantitative measurements. It is simply a charged insulated metal plate. I have found that when this is exposed to Röntgen's rays it rapidly loses its charge, and the test is so delicate that I have by this means been able to detect the rays after their passage through a zinc plate ¼ inch thick. The leakage caused by these rays differs materially from that investigated by Elster and Geitel and due to ultra-violet light. In the first place the Röntgen rays discharge positive as well as negative electricity, and secondly, the leakage goes on even when the electrified plate is embedded in paraffin, ebonite, mica, sulphur, etc. This shows that all substances through which the Röntgen rays are passing become for the time conductors of electricity. This result seems to me very suggestive both as to the nature of the rays and also of the conduction through the insulator."

AN ELECTRIC LIGHTSHIP FOR THE BOSTON STATION.

The first electric lightship built in this country is the one now on a Connecticut station; the second is building, and she will be known as light vessel 66. By an odd coincidence in figures her contract price is $66,000. She is for the Boston station and will be launched some time in April. This torch-bearing vessel is of composite construction, wood and steel entering about equally into her hull, this build being more durable, easier to take care of, and safer in case of grounding than one of all metal. Her dimensions are: Length, 66 feet; breadth, 28½ feet; depth, 13 feet.

From the masthead two bunches of red light will warn the mariners of dangerous water. There will be four 110-volt 100-candle-power lights at each masthead, enveloped in red glass, which will be about 43 feet above sea level. The extreme length of her masts will be 67 feet, including an 11-foot topmast on each. The masts will be made of iron 16 inches in diameter at the thickest part. Wire rigging will be used, and enough sail will be bent on to give her steerage way in case she is torn from her anchorage.

In addition to a spread of canvas the lightship will be equipped with a 300-horse-power engine, two boilers of the Scotch type, 300-horse-power each, and two donkey engines for hoisting purposes. Her screw is four-bladed, eight feet in diameter, and of composition. She will be moored with a 5,000-pound anchor. The vessel will be equipped with two lifeboats and additional anchors, a powerful steam siren for whistle, and a 1,000-pound bell. A mate to this vessel is being built in San Francisco for use on the Pacific coast.

X-RAYS IN OPERA GLASSES.

A loud laugh went over the State of New Jersey on Feb. 19, when Assemblyman Reed, of Somerset County, introduced a bill in the House, at Trenton, prohibiting the use of X-rays in opera glasses in theaters.

LETTERS TO THE EDITOR.

THE N. E. L. A. STANDARD RULES ON CONSTRUCTION AND OPERATION.

On behalf of the Committee on Standard Rules for electrical construction and operation of the National Electric Light Association, I take pleasure in sending you herewith a statement as to the present condition of the work undertaken by that committee for the forming of a joint committee, composed of the various electrical, insurance and allied interests, which joint committee, it is proposed, shall take up the most important matter of the codification, promulgation and enforcement of one standard set of rules which shall meet as fully as possible the conditions that now exist, be up to date, and prove acceptable to the various interests affected by electrical construction work.

The following organizations were invited to co-operate, and our committee is most pleased to state that in every instance the invitation extended has been accepted, and in the appended list is given the names of the delegates appointed to represent those various organizations; and the character of the appointments made is in every case so high as to guarantee a most careful consideration of the important questions to come up and their treatment in an able and conservative manner. The list of those who have been invited to co-operate with our committee, together with their delegates, is as follows: American Institute of Electrical Engineers, Professor Francis B. Crocker, Columbia College, New York; American Street Railway Association, John A. Seely, Consulting Electrical Engineer; National Board of Fire Underwriters, William H. Merrill, Chief Electrician, Chicago, Ill.; Western Union Telegraph Company, A. S. Brown, Chief Electrician, New York; Postal-Telegraph Company, Francis W. Jones, Chief Electrician, New York; American Institute of Architects, Alfred Stone, Secretary, Providence, R. I.; National Association of Fire Engineers, Captain William Brophy, Electrical Expert of the Commissioners of Wires Department, City of Boston, Mass.; American Bell Telephone Company, C. J. H. Woodbury, of the Engineering Staff, Boston, Mass.; General Electric Company, Lieut. S. D. Greene, General Manager Lighting Department, New York; Westinghouse Electric and Manufacturing Company, Charles F. Scott, Electrician, Pittsburg, Pa.

The committee of the National Electric Light Association who have had charge of the standard rules of that association for a number of years, and who have taken the initiative in the forming of the joint committee, are as follows: William J. Hammer, Chairman, Consulting Electrical Engineer, New York; James I. Ayer, Consulting Electrical Engineer, Boston, Mass.; Harrison J. Smith, General Operating Superintendent Edison Electric Illuminating Company, New York; E. A. Leslie, Vice-President and General Manager Manhattan Electric Light Company, New York City; Capt. William Brophy, Electrical Expert of the Commissioner of Wires of the City of Boston, Mass.

In view of the various misconceptions of the committee of the National Electric Light Association and of the joint committee, it will not be out of place to state that the various associations have been invited to send a delegate to the joint conference, on March 18, but not in any way was it intended to commit them to any definite action at the meeting. It is proposed that the various rules which have been promulgated by the various interests, electrical and insurance, shall be taken up for consideration and thoroughly discussed from the standpoint of the various interests represented at that meeting, with a view of forming a new code comprising the best that is in the various sets of rules now in vogue, and new matter considered advisable; that the delegates should take part in the discussion and vote upon the various matters which would come up bearing upon the importance and value of the rules submitted, and after a code has been prepared which has met with the approval of the various delegates attending the meeting, that the code thus prepared should be submitted by the various delegates to the bodies which they represent with the intention that they shall ultimately, if it is deemed advisable by the various national organizations, be approved by them. And, as stated before, it is not the intention that the questions taken up in the discussion shall commit the various organizations to any definite decision in this matter at this meeting or thereafter, if they should deem it inadvisable to co-operate.

It seems almost unnecessary to call attention to the paramount importance of securing the adoption of one single standard set of rules. Examine the condition of things which exists to-day, in which we have the code of rules issued by the National Electric Light Association, which, as is well known, are largely the basis of all the rules used in the United States; the code adopted by the National Board of Fire Under-

writers; the rules issued by the various illuminatting companies; the rules of the Manufacturers' Mutual, of the New England and similar associations; the rules now about to be issued of the Fire Department of the City of New York. and similar organizations in other cities, the independent sets of rules prepared by consulting engineers, insurance experts, etc., which are more or less in vogue in the United States. Unquestionably, the existence of these various rules, which are all of them of greater or less intrinsic value and importance, leads to a tremendous amount of confusion, misunderstanding, expense, litigation, and I think will be generally admitted frequently to the interpretation and enforcement of the various rules largely in accordance with the personal views of the local inspectors. By securing the adoption, promulgation and enforcement of one single standard which will meet with the approval of the various electrical, insurance and allied interests, and which rules shall be the result of the joint action of these various interests and not be fathered by any particular association, electrical, insurance or otherwise, we shall arrive at a condition of things which has been hoped for and worked for for many years past. It seems, then, as the preliminaries for the proposed joint meeting have been so successfully inaugurated, that it is the duty of not only the various organizations, which are co-operating at this joint meeting, but electrical and insurance men, and those connected with allied interests to lend every assistance and encouragement in their power to secure the aimed at and much to be desired result of the adoption of a single National Code of Rules.

On behalf of the preliminary committee of the National Electric Light Association, who are arranging the details of the meeting which is to be held on the 18th of March (and probably on the 19th as well), I wish to extend an invitation to any one to send, either to my address or to Mr. George F. Porter, Secretary of the National Electric Light Association. 136 Liberty street, any criticism or suggestion upon any of the rules now in vogue or matter which might be included in the proposed new code.

In conclusion, I take pleasure in stating that the American Society of Mechanical Engineers have extended the courtesy of the use of their headquarters at No. 12 West Thirty-first street, for the holding of the proposed joint meeting, on March 18 and 19, 1896.

WILLIAM J. HAMMER,
Chairman National Electric Light Association Committee.
Havemeyer Building, New York City, Feb. 20, 1896.

MAGNETIC CUT-OUTS.

Your editorial of Feb. 5, and advertisement relating to magnetic cut-outs, together with a published article showing the slow and unsatisfactory action of fuse metals for heavy currents, were all most interesting. Letters to your valuable paper from Mr. Walter E. Harrington and the writer have, in view of what was so ably pointed out, argued that for traction work fuses were of little, if any, value, and that the heavier their work the more unsatisfactory they were. For cases like the Metropolitan West Side Elevated Railway, in Chicago, the Nantasket Beach Railway, in Massachusetts, or similar ones, they would be wholly useless, as we then pointed out.

Mr. Harrington complained that the blistering of the contacts, due to arcing, has been urged as a serious objection to the use of magnetic cut-outs. He suggested one simple and easy method of overcoming this and the writer another. The cuts in the advertising columns suggest a third, which seems to be the best. These appear to show a simple design in which there is first a metallic break, followed by an opening of the circuit between two carbon contacts, thus throwing the arc upon the carbons where its damage will be slight. Whether or no this be the method illustrated (which one can only guess at in the absence of description) it appeals to me very strongly as a traction engineer. Being one of the pioneer electricians of the now national institution, the trolley system, who shared the great and at times discouraging difficulties of its early development, one can doubly appreciate the value of such a cut-out. For trunk line branches, of which the writer is laying out work for some, one could hardly devise anything better.

Having thus minimized the effects of arcing upon the contacts of the cut-out, the adjustment of the magnet, so as to open the circuit the instant the current exceeds a specified value, is a mere matter of design and workmanship.

JAMES H. BATES.
New York.

OF THE GREATEST VALUE AS REFERENCES.

Permit me to testify to the very great value of the leading article in your number of Jan. 8, describing in very considerable detail the large station of the local Edison Company. Articles of this kind, which are quite frequent in your journal, not only aid one in keeping informed of what others are doing, but are of the greatest value afterwards as references in case it is desired at a later date to do any work of a similar kind or to collate information in regard to a particular subject.

Wishing you still further success, even in the mature development of your valuable journal, etc.,

New York. CHAS. E. EMERY.

THE BEST OF ITS KIND.

I consider the article on the Edison station the best of its kind that I have yet seen, as regards lucidity and comprehensiveness, and, especially perhaps, as regards the clearness and general excellence of the illustrations, which, to my mind, are in every way admirable; strikingly so, indeed, when compared with the bulk of plate illustrations, which have been appearing of late, and in which, in numerous cases, even an expert would be puzzled to designate the alleged apparatus. You have certainly placed the electrical profession under obligations in the production of so valuable a contribution to the literature on central stations, and I am sure it is fully appreciated. Wishing you continued and increasing success,

New York City. WM. MAVER, JR.

THE VIENNA AIR CHAMBER RAILWAY CONDUIT.

Your issue of Jan. 29 contains an article under the head of "The Air Chamber Conduit in Vienna," referring to a system wherein a small conduit is used, the trolley wires being supported in an air trap so that the water cannot reach them. You erroneously credit this invention to Mr. R. W. Barkley, of New York. This scheme was patented by the writer in the United States and numerous foreign countries (including Austria) about ten years ago. Notice the fundamental claims 7 and 8 in my United States patent, No. 345,845, of July 20, 1886. I mention this merely as a matter of history.

J. C. HENRY
Denver, Colo.

NEWS AND NOTES.

EXAMINATION OF NEW YORK ELECTRICIANS.

Assemblyman Trainor has introduced in the New York Legislature a bill providing for the appointment in each judicial district of the State of a board of electrical examiners. It provides that four persons shall be appointed by the Governor in each district to comprise a board, to be charged with the duty of determining the qualifications of persons engaged in the installing or operation of electrical apparatus and appliances in buildings for light, heat and power. The board shall be bi-partisan and be empowered to collect not less than $3 and not more than $10 for each person examined and licensed. The members of the board shall receive $5 a day for each day's actual service.

THE MAGNETIC INFLUENCE OF THE PLANETS.

In the meteorological records of the St. Petersburg Academy of Sciences, Vol. XVII., there is an exhaustive discussion of the magnetic observations made at St. Petersburg and Pawlowski from 1878 to 1889, and their bearing on the influence of the various planets on the magnetic declination. From this it would appear that all the planets exercise a marked influence not only on the absolute value of the declination, but also on its diurnal variation. All the planets except Mercury increase when they are near the earth both the absolute value of the declination and the periodic portion of the daily variation. The extreme values of the declination differ in a year by 0'.85. Taking this amplitude as unity, the following numbers express the amplitude of variation corresponding to an entire synodic revolution of the respective planet: Mercury 0.58, Venue 0.61, Mars, 0.59, Jupiter 0.40, Saturn 0.12, Uranus 0.15, Neptune 0.27.

In the current number of "Nature" there is an interesting article by Professor A. Schuster, criticising this alleged magnetic influence. Professor Schuster thinks that "among the many improbabilities of magnetic influences which are hanging over us, that of a planetary effect may for the present be set aside."

THE CONDUCTIVITY OF ALUMINUM.—A CORRECTION.

In a letter addressed to Mr. G. L. Addenbrooke, and published in the London "Electrical Review," Lord Kelvin states that, owing to an absurd error, the conductivity of aluminum given by him was erroneous, and that his corrected figures show that the conductivity of aluminum does not differ materially from that given in text books and books of reference. Lord Kelvin's supposed corrected figure was given in our last issue, on page 196, which should therefore be disregarded.

THE

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[INCORPORATED.]

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CONTENTS.

THE WILSON-SQUIRE EDUCATION BILLS.

THE liberality of most of our State Governments in the establishment of universities has thus far made it less incumbent upon the general Government to inaugurate large educational undertakings, although measures of this nature have been more than once suggested, more particularly for certain sections of the country, especially the South. But that the Government possesses vast potentialities for aiding the present established institutions must be apparent, and we are glad, therefore, to note an earnest attempt to bring about a much needed addition to the naval engineering resources of the country. Bills have been introduced in the United States Senate and House, respectively, by Senator Squire, and Representative Wilson, to maintain courses of instruction in naval engineering in the several scientific and technological schools of the country, and so to endow and support such courses, as well as aid and strengthen the present engineering courses of all such institutions, that they may become recognized as proper fitting schools for the United States Naval Engineering Service. The engineering departments of the State and other colleges and universities are likewise included and benefited.

While the chief aim of these bills is to afford a means for increasing the staff of naval engineers, which the growing needs of the Navy has already overtaxed, the benefits which the measure, if adopted, will confer on engineeing schools in general is manifest. The extent to which electricity is now applied in the modern warship, as indicated, for example, in Dr. Park Benjamin's article on the "Nerves of a Warship," in "Harper's Magazine" for March, must necessarily require that special attention be paid to electrical engineering in a course adapted for the naval engineers. Hence the electrical profession at large will be directly benefited by the provisions of the bill. But leaving out of consideration all direct benefits, the fact that the supply of naval engineers is not equal to the demands at the present time, is sufficient to call for the passage of these bills as a matter of the first importance to the welfare and security of the country. Our readers may aid the cause of technical education by communicating with their representatives in both Houses of Congress, urging favorable consideration of these bills.

THE NIAGARA ENTERPRISE.

ONE more step forward in the Niagara power enterprise is to be noted in the announcement of a contract for the poles which are to be used in the transmission line from the Falls power house to Buffalo. A further point of interest is the fact that the poles will be wooden. They will be Canada cedar, all 8 inches in diameter at the top, and ranging from 25 to 50 feet in length. They will be set ordinarily 50 to the mile, but where exposed to unusual wind strains, etc., 100 to the mile will be used. The poles will have two crossarms. The current, as already noted, is to be transmitted 3-phase from point to point.

Within the last week or two the wintry condition of the weather has interfered greatly with the flow of water over the Falls, and it is said that not since 1848 has there been a season when the Niagara River has so closely approached the state of the Red Sea when Pharaoh and his host essayed to

cross it. Some months ago, Mr. Andrew Green, one of the Niagara Reservation Commissioners, raised a shrill cry of alarm over the early coming of a time when the various utilizations of Niagara power would deprive the Falls of their beauty, because there would be no water left. It is evident that Nature, and not man, is the agency to guard against. Mr. Clemens Herschel, the distinguished hydraulic engineer, in a recent comment on such views, shows that if all the present work were carried out to an extreme and water capable of developing 400,000 horse-power were diverted, the sheet of water at the American Fall would be lessened from 4 feet to 3.74, and that of the Horseshoe from 14 feet to 13.08. The time is certainly rather remote when all this energy can find customers, but it might be a blessing if it could be used to-morrow. Professor Shaler, of Harvard, in pointing out that the Falls recede as rapidly as they do because of the eating out of the underlying soft strata, has suggested, first, diversion of part of the stream, and, second, the supporting by masonry of the superincumbent shelf of limestone over which the limpid water plunges. The first part of his programme of conservation is now being put in force; the second is worthy of consideration by those who wish to "save Niagara."

STORAGE BATTERIES ON ELEVATED RAILROADS.

FOR several years past the officials of the New York Elevated Railroad system have been reported as earnestly studying the question of the application of electricity to their system of transportation, and at last we are to have a trial of an electric system on one of the branch roads, running for a distance of less than of a quarter a mile. The New York Elevated has been harshly criticised in the past for having so long delayed taking up the subject, considering the examples of successful electrical operation of elevated railroads afforded by other cities, such as Chicago and Liverpool. Of course, the extenuating circumstance may always be cited that the changing about of an established system of steam locomotion, the abandonment of several hundred locomotives, and the investment of five or six millions of dollars in new equipment, are not to be lightly passed upon.

Now that the New York Elevated roads have again taken up the subject, it is interesting to compare the present proposed system with those which have preceded it. The first to undertake electrical work on the elevated roads, it will be remembered, was Mr. Leo Daft, who, in 1884, placed his locomotive, the "Ampere," on the Ninth avenue line. He was succeeded by Mr. Frank L. Sprague, with a car equipped with individual motors, practically the same system now in operation in Chicago and in Liverpool; and, again, Mr. S. D. Field attacked the problem with a locomotive of his direct connected crank type. The present experiment is noteworthy, in that while following the general lines of a motor car of the type which the World's Fair "Intramural" road made so familiar, it introduces the additional feature of a storage battery carried on the motor car. Of course, it is not contemplated that the storage battery will be used for anything more than as a regulator and as a temporary source of current in case of accident, or to bridge switching points; but the reasons which dictated the placing of the battery on the car in preference to installing it at the power station are worthy of full consideration. These reasons have been deemed of sufficient weight to induce the company installing the electrical equipment to undertake it with confidence in its successful operation, and the outcome of the experiment will be watched with the keenest interest by electrical and railroad engineers.

PACIFIC CABLE SCHEMES.

WE publish this week a report of the recent hearing in Washington, before the Senate Committee on the Pacific cable schemes. The situation is interesting and reveals a rivalry between English and American capital that is surprising to many people, though certainly not to any who have been watching the rapid development of affairs in the Far East. The Spalding plan is understood to have English enprise behind it, and proposes a cable to the Sandwich Islands from San Francisco, where, presumably, it would link into the British cable system that has been developing so persistently and so successfully in that part of the world. The Scrymser plan not only contemplates a Hawaiian cable, but reaches out to Japan and China. There it would presumably have to link on to the existing lines controlled by English capital. Col. Spalding has already his exclusive Hawaiian concession and is backed by well-known Americans, including Abram Hewitt, D. O. Mills, Col. Fred Grant and Gen. Wager Swayne; but this concession depends upon a subsidy from the United States. Mr. Scrymser claims that his company represents competition and lower rates by at least one half. The remarkable thing about this rivalry is that both plans appear to depend on a landing in the United States, whereas only a year or so ago the Colonial Conference meeting at Ottawa discussed seriously landing on British Columbian soil, and Mr. Alexander Siemens was himself in attendance to furnish the information of which a digest appeared at the time in these pages. It is evident, anyhow, that we shall soon have a Pacific cable, and it will be laid none too soon. The cost averages around $4,000,000, and as to subsidies Hawaii has already pledged $40,000 a year to Mr. Spalding and his associates for a cable to be laid not later than Nov. 1, 1898.

ROENTGEN RAYS.

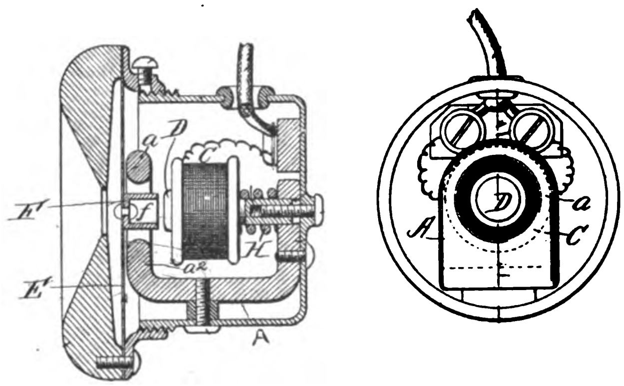
WHILE one may not always be in full accord with the views of Dr. Lodge, who is a radical in science, his statements are always interesting and contain much food for reflection. His review of the Röntgen ray theories which we print this week is an excellent digest of the subject, and his own experiments, corroborating the results of Professor Röntgen, indicate pretty clearly to our minds that the latter, like a true scientist, deliberated well and long before venturing before the public with his remarkable results. Perhaps the most interesting, not to say startling fact established since Professor Röntgen's publication is the announcement by Professor J. J. Thomson, that the X-rays dissipate the electrostatic charge of any body upon which they may fall, no matter how that body may be protected from discharge, and further, that the nature of the charge, whether positive or negative, is immaterial. It is this latter property which distinguishes the X-ray action from that of the ultra-violet rays discovered by Elster and Geitel, which have the power of dissipating but a negative electrical charge. We think that this property of the X-rays will find an important place in the establishment of the theory of the X-rays, and the corollary drawn by Professor Thomson that all bodies, when under the influence of X-rays, become conductors, may find application in science and in the arts.

TELEPHONY AND TELEGRAPHY.

PRATT AND ALLEN'S TELEPHONE RECEIVER.

MANY have been the efforts to increase the sensibility of the telephone receiver, with the result that the relative arrangement of magnet and diaphragm has received a large number of variations. One of the most recent attempts of this kind is that embodied in the receiver illustrated in the accompanying engravings, due to Mr. H. P. Pratt and H. A. Allen, of Chicago.

The primary object of the instrument is to approximately double the variation of magnetic disturbance caused by the vibration of the diaphragm, and to such end certain useful lines of force are caused to pass through synchronously varying air spaces which interrupt metallic circuit portions between the poles of a magnet. The metallic circuit portions are provided by the diaphragm and an armature thereon, and the air spaces, respectively, occur between the diaphragm and one pole and between the armature and the opposite pole. The air space between the diaphragm and adjacent pole is varied by the vibration of the part of the diaphragm, and synchronously therewith the air space between the armature and the adjacent pole is varied.



PRATT AND ALLEN TELEPHONE RECEIVER.

As will be seen, this magnet, A, is formed with an annular portion, a, which constitutes one of its poles. The helix C is arranged upon the opposite pole of the magnet, and the pole upon which the helix is thus arranged is formed by a soft iron core, D, attached to an arm of the magnet and arranged opposite the space which is circumscribed by the annular pole, a, of the magnet.

The diaphragm E is separated from the magnet and is arranged in front of the annular pole a of the magnet, and carries upon its rear side a small armature F, which is attached to the center of the diaphragm. This small armature is arranged opposite the pole D and made hollow, so that, while it can be made light, it can comprise sufficient metal to permit it to carry a suitable number of lines of force, and also have sufficient cross-sectional area to enable the diaphragm to carry an increased number of lines of force.

It will be seen that pole a is arranged in a plane which is parallel to the plane of the normally-quiescent elastic diaphragm and interposed between the diaphragm and the opposite pole of the magnet, and that the armature which is carried by the diaphragm is arranged to intersect the plane in which the pole a is positioned. Certain useful lines of force, therefore, pass through metallic circuit portions provided by the armature and diaphragm, and through air spaces which interrupt the metallic circuit portions and which are synchronously varied by the vibrations of the diaphragm carrying the armature. In this way, it is claimed, the magnetic disturbance is augmented and practically doubled, thereby greatly increasing the efficiency of the instrument.

DRAWBAUGH WANTS A TELEPHONE PATENT.

Daniel Drawbaugh and his representatives were before the Senate Committee on Patents at Washington, on Feb. 15, advocating the passage of a bill that will enable him to go before the Patent Office and prosecute his claim for a telephone patent from which he has been debarred by reason of the finding of the Patent Office that his invention was in use for more than two years before his application was filed. Drawbaugh contends that it was only in use as an experimental affair, and not commercially, as required by the law. His alleged invention is similar to those upon which the Berliner patents, now in the Supreme Court, are based.

THE PROPOSED HAWAIIAN CABLE-U. S. SENATE HEARING.

THE United States Senate Committee on Foreign Relations gave the proposed telegraphic cable propositions connecting the United States with the Hawaiian Islands and the Asiatic coast, a hearing, at Washington, on Feb. 19. The proposition of the New York Company, headed by James A. Scrymser, which is looked upon with favor by a number of the committeemen, was materially amended in a statement laid before the committee. In addition to its original plan of constructing a line to Japan by way of the Hawaiian Islands, the company now proposes to extend the cable to such other islands in the Pacific Ocean as may be selected, and to the Coast of China, making that one of the termini instead of the Island of Japan.

A concession of importance is made in the matter of rates for messages and the use of the line by the Government. The bonus asked is $150,000 for a period of twenty years, during which time the company agrees to transmit all Government messages free of cost, and after the termination of the period of twenty years, when the bonus shall also cease, the company binds itself to forever transmit Government messages over its cables free of all cost. The usual stipulations are set forth relative to the seizure and control of the cable by the Government in time of war or other emergency.

The rate for ordinary private messages between the United States and Japan and China is fixed at $1.25 per word, and on messages between the United States and the Island of Cahu, in the Hawaiian group, at 35 cents per word. Press rates are not to exceed one-fourth the rates charged for ordinary messages.

The company agrees, within ninety days after the approval of the act, to deposit with the Treasury of the United States, United States bonds to the amount of $100,000, as a guarantee of its good faith—such bonds to be subject to forfeiture in case the company shall fail to complete the line to Hawaii within eighteen months, and between Hawaii and Japan within three years.

President Scrymser, in a statement submitted to the committee, says that the only obstacle to the early and successful establishment of this cable is the so-called exclusive grant by the Hawaiian Government to Col. Spaulding. Mr. Scrymser called attention to the fact that this grant was subject to and became operative only through the action of the United States Government. The statement also emphasized the fact that the competing company asked the same bonus for a service that extended between the United States and Hawaii alone. The United States Government, in granting a subsidy to the Spaulding Hawaiian cable would, Mr Scrymser stated, be indirectly perpetuating an existing monopoly of cable communication with China and Japan, which it was the object of his company to destroy, it now costing $2.36 per word from New York to Japan, and $1.76 per word to China. The through rate of $1.25 from San Francisco to Japan and China was, Mr. Scrymser asserted, very much less to the people of the United States, and more advantageous to the general Government.

The company submitted to the committee a copy of a letter addressed to Abram S. Hewitt, to which the company had as yet received no reply, but which Mr. Scrymser stated, was proof of the statements of his company that there was a "strong English influence behind the Spaulding scheme, and that the United States is expected to make a contribution to a monopoly enjoyed by foreign companies in China and Japan, of which Sir John Pender is chairman."

The letter to Mr. Hewitt submits to that gentleman the substance of a conversation had between himself and Edmund L. Baylies, vice-president of the New York company, which, Mr. Baylies says, was reduced to writing in order that there might be no further misunderstanding. This letter states that Col. Spaulding, while in England, made a conditional contract for the manufacture of his Hawaiian cable; that when he returned he brought with him a letter from Sir John Pender to Mr. Hewitt asking the latter to organize an American company; that such company was organized, and invitations issued for subscription to its stock, the understanding of Mr. Hewitt being that so far as his subscription of 1,500 shares was concerned, Sir John Pender was to guarantee him (Hewitt) against loss.

These documents were laid before the committee for the purpose of showing, as Mr. Scrymser claimed, that the competing company, also seeking authority to build a cable, was not American in its origin, but was backed by English capital, controlled by English influence, and sought to kill off the competition in cable tolls between this country and China and Japan,. that the company which Mr. Scrymser was seeking to establish and maintain. No action was taken by the committee.

MISCELLANEOUS.

ELECTRIC HEATING.—II.[1]

BY W. S. HADAWAY, JR.

As bearing upon this subject I beg to quote from a recent letter from the American District Steam Company of Lockport, N. Y.

"We observe that you recognize the futility of electricity competing with steam for diffused heating on a large scale, but there is a wide field for electrical companies in connection with their exhaust. In blocks of buildings where power is required to run elevators, or for other purposes, the proprietors will run their own power if they have to do their own heating, but if the electric company can heat the building it can get the power at a good profit, and there is a profit in both heating and power.

"We have just constructed a heating plant for the Rochester (N. Y.) Gas and Electric Company, who are doing just this thing; they start off with 5,000,000 cubic feet of space to heat in manufacturing and business blocks, and secure the running of several engines in the same buildings. They supply the steam from their station in underground pipe and power by wire. They could not get the power without doing the heating."

Careful study of the question of multi-potential heat supply from both the engineering and business standpoints, can hardly fail to give the utmost confidence that results of the greatest value can be obtained along this line. A total fuel efficiency of 35 per cent. for combined low and high temperature heating is certainly obtainable, and probably a still higher efficiency may be secured from operations on a large scale. It is in this connection that I look for the best immediate results of electric heating in domestic life. The electrical engineer of to-day realizes that the ordinary light and power station is extremely wasteful as a heat generator and distributor, and the only way to improve these conditions is to introduce a basis of supply in which the load factor is a larger percentage of the station capacity and in which what are now wasteful by-products may be utilized. This feature should receive the greatest possible care; space does not permit a discussion of Crompton's valuable paper on this subject and its practical bearings on the conditions existing to-day in this country, as shown by the reports of the Massachusetts Board of Gas and Electric Light Commissioners and the data collected by the National Electric Light Association.

Aside from electricity for cooking we find in the modern apartment houses a comparatively high distributive heat efficiency. The rooms are heated by steam, as is the water for bathing and cooking purposes. Electric lighting is available, but low heat efficiency is found in cooking, except in cases where gas is available. I do not question the value of gas for fuel in cooking; I take the ground that when a boiler plant is required for room and water heating and the electric plant for lighting, the use of gas in cooking is unnecessary and comparatively expensive. In these houses electricity is already being used instead of alcohol lamps for heating chafing dishes and small tea kettles for five o'clock tea, also for heating curling irons, sad-irons for laundry work and pressing, etc., and it appears to be a question of but a short time before electric ovens, broilers, and small portable stoves will replace the range or gas stove on a considerable scale. The apartment house supplied with its own boiler and electric lighting plant approaches more closely the proper conditions for electric heating than any other mode of domestic life, as all the conditions essential to economical working are already present.

The foregoing deductions have been introduced to indicate broadly wherein the true economical basis of electric heating lies. Like all general considerations, they are qualitative rather than quantitative in character. We find in industrial and commercial practice a great number of heat applications, either at high or moderate temperatures, in which close regulation and facility of control are necessary and where electric heating on some scale is applicable. The introduction of electric lights and motors has brought into use in central stations and isolated plants a vast amount of electrical generating apparatus, so that at the outset our problem is almost wholly one of applying electric heating apparatus on circuits already established, primarily for other purposes. On these circuits we are usually able to show apparatus to do the work required better than it is at present accomplished. First cost and cost of operating are not the sole considerations in any apparatus; in addition to the cost the collateral advantages derived from its use must be considered.

In domestic work there are large numbers of chafing dishes, small tea kettles, sad-irons, etc., in use. Once used the value of this method of heating is well appreciated, and extensions of it are made to more and different work. In this slow, conservative way, electric heating in households is progressing, and there are indications of a more and more rapid general reception and use.

There are some installations in which all or nearly all the cooking is done by electricity. These are generally successful and economical, according to the extent to which extensive water heating is eliminated. Laundry and pressing irons are found almost uniformly satisfactory. So with all devices used in the dining room, as, for example, chafing dishes and small tea kettles. When it comes to the kitchen the same feeling of cleanliness and elegance as for the dining room is expressed and hoped for, but the housewife is not so intimately in contact with the apparatus, and we encounter ignorant manipulation which, however, generally does no other harm than to add to the expense of running. But fortunately the manipulation and control of the apparatus is so simple and saves the servant so much hard work that an honest effort is usually evident to use it economically.

In industrial work the progress of electric heating is more rapid than in domestic applications. There are cases where heating by electricity is found cheaper than by fuels, setting aside all collateral advantages. In electric cars the equable distribution of heat on a basis of effective warming is sufficient, in the judgment of shrewd business men, to warrant employing the method and apparatus, even at considerably greater cost than former methods of heating.

We have before us for the future two methods for the distribution of heat; the first a multi-potential heat system in which steam and electricity are the means of transmission, and, second, a constant potential heat system in which electricity is employed as agent for diffused heat work in large volume, and the heat of resistance, either directly or with the additional heat of combustion of carbon, is used for high temperature purposes. The first is a combination of well-known engineering practices and represents elements in successful use at the present time. The second method appears more difficult, as it includes new methods of application and untried apparatus. For the present we have to approximate the probable final conditions by using materials at hand, so far as they will go, with reasonable economy, using every energy to broaden the general conception of the help and convenience arising from central station heat supply.

1. Car Heating.—The electric car heater has a small coal stove as its chief competitor. The car stove is usually placed midway in the car, the seat on one side having been cut away to let it fit in snugly, taking thereby the seats of two passengers. This system of heating is manifestly a poor one considered on the basis of heat distribution, and it also aggravates the faulty ventilation of a street car by gases from the coal burned.

In house or space heating on a considerable scale the generator can be located at a convenient point and the heat energy distributed efficiently by hot water or steam. In electric street cars the space to be heated is so small as to practically preclude the economical use of this method of heating. Hot water storage systems have been suggested and tried; but the objections of charging, attendance, etc., are evident.

The electric railway company usually owns its own generating plant, which has been erected specially for the purpose with good boilers, efficient engines, and large unit generators. The cost of power is a minimum, and there are cases in which it is figured to cost not over $2 per horse power per month. It is in a measure the ability to generate the power cheaply that makes it profitable to operate street railways by electricity. This same reason makes a certain amount of energy available for effective car warming at reasonable cost. The amount of energy available is dependent upon local conditions peculiar to each road.

Most of the car heaters now used are air heaters; that is, the resistance is so arranged as to permit the air to impinge directly against it and carry away the heat by convection currents. The heat ascends to the monitor and is rapidly diffused with the cold air sifting in through openings in ventilators and window frames.

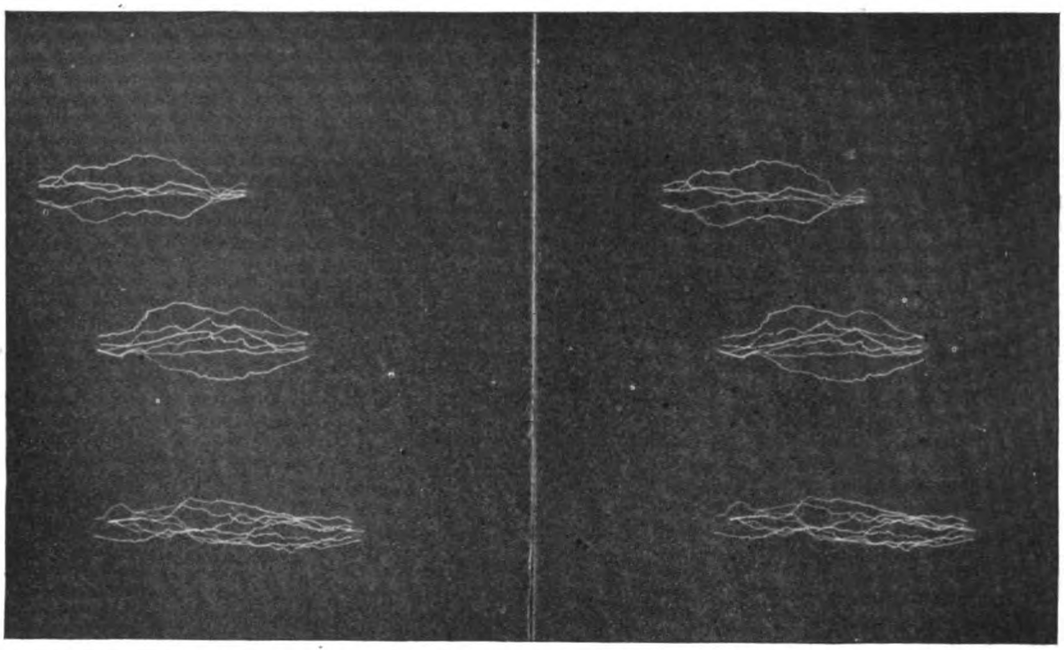
It may well be questioned in the light of modern heating practice whether this form of heater is best adapted for the peculiar conditions in car heating work, which really should be not heating at all, but effective warming. In common house heating, where electric heaters are used to give results immediately, they are connected in circuit; this is a better way to make the heater than a radiating surface. But in car work, where the heater is practically continuously in circuit, the radiator forms a better means of keeping a large percentage of the heat delivered at or near the floor of the car and about the bodies of the passengers.

1 Abstract of paper read before the Am. Society of Heating and Ventilation.

ELECTRICAL DISCHARGES INVESTIGATED BY MEANS OF STEREOSCOPIC PHOTOGRAPHY.[1]

By Professor Charles F. Himes, Ph.D,

In a previous article urging the introduction into the market of a stereoscope with simple adjustments adapting it more completely to comfortable and effective use, and a greater range of applications, attention was incidentally called to some of the peculiar possibilities of stereoscopic investigation of space phenomena, aided by photography. The accompanying stereograph may serve as an illustration of a permanent record of a phenomenon in space, so evanescent as to elude direct observation. The subject is a succession of sparks between the poles of a Holtz machine. The pictures seem identical, even upon close inspection. There seems to be nothing in these lines, representing the paths of the several sparks, to indicate with any certainty their relative positions in space. As far as either single picture gives any information they form simply a bundle of very irregular and very confused lines. They might all be in the plane of the paper, or any one of them can be regarded as lying in front of, or behind the plane of the paper, at will. But when the pictures, viewed as a stereograph, are binocularly combined by aid of the stereoscope, or otherwise, they immediately assert their character as right and left eye pictures. The confused mass resolves itself into distinct and separate lines, each with its peculiar shape and its true position in space. As the sparks were taken not simultaneously but in succession, with any desirable interval of time between, it is plain that each one has impressed upon it, the effect of any conditions peculiar to it, and that by varying conditions under which the sparks may be produced, in turn, the effect of any one upon the shape, position and general character of the spark can be studied. Appearances that in a single photograph might be assumed to be due to difference in distance, might require some other explanation when the binocular pictures negative that assumption.



Electrical Discharges Investigated by Stereoscopic Photography.

The poles in this case were five inches apart, with small condensers attached. The camera was an ordinary stereoscopic camera with the usual separation of the lenses. It was focused upon a card held between the poles, and the lenses were uncapped, in a darkened room of course, and the machine turned until the desired number of sparks had passed. The camera was then elevated, and a second and third series of sparks obtained on the same plate. At times branches of such extreme delicacy are obtained that they cannot be rendered by a process block. Bromide plates from the most rapid to the slowest process plates, non-halation and orthochromatic, and even wet collodion plates all gave excellent results.

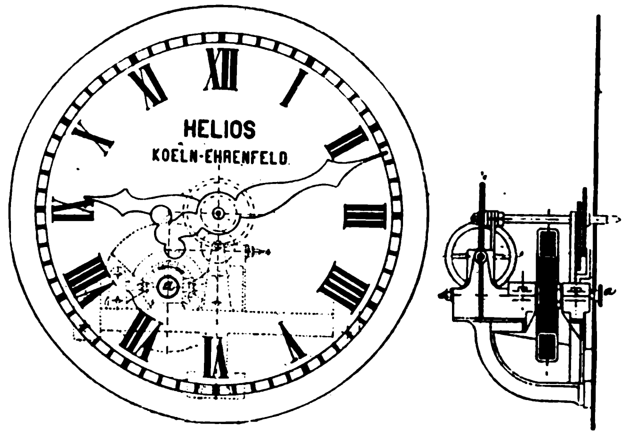
The ordinary stereoscope may be used for viewing the accompanying stereograph; but an ordinary steel-framed pair of spectacles, with lenses of about six inches focus, can be adapted to the purpose by widening the distance between the lenses, by cutting the bridge so that the eyes may look through the edges instead of the centers of the lenses. Such spectacles will be found more convenient in many cases than the ordinary instrument. Of course, those accustomed to combine the pictures of a stereograph without any instrumental aid will have no difficulty in this case.

The separation of the pictures in the accompanying illustrative stereograph has been made greater than normal in reproducing, and may, therefore, occasion difficulty for some. In such cases it may be considered as illustrating more than was intended, namely, the desirability of an adjustable stereoscope.

[1]"Photographic Times," February, 1896.

ALTERNATING CURRENT CLOCKS IN COLOGNE.

For some time past the Coerper system of alternating current clocks has been in operation on the circuits of the municipal plant in Cologne, Germany. These clocks consist of an alternating current motor, illustrated in Figs. 1 and 2. The armature of these motors is an unwound iron star which drives the hands by a suitable clock train. The clock must evidently indicate correct time as long as a master alternating clock at the central station corresponds with a pendulum clock also at the station. If the master clock shows a small variation from the normal time, it is easily corrected by the engineer, who changes the number of alternations of the current slightly, and thus influences the synchronous clock motors correspondingly. This regulation is extremely simple. The clocks show but a very small daily variation and thus constitute the most sensitive tachometers, and at the same time prove the close regulation of the machines.



Helios Alternating Current Clock.

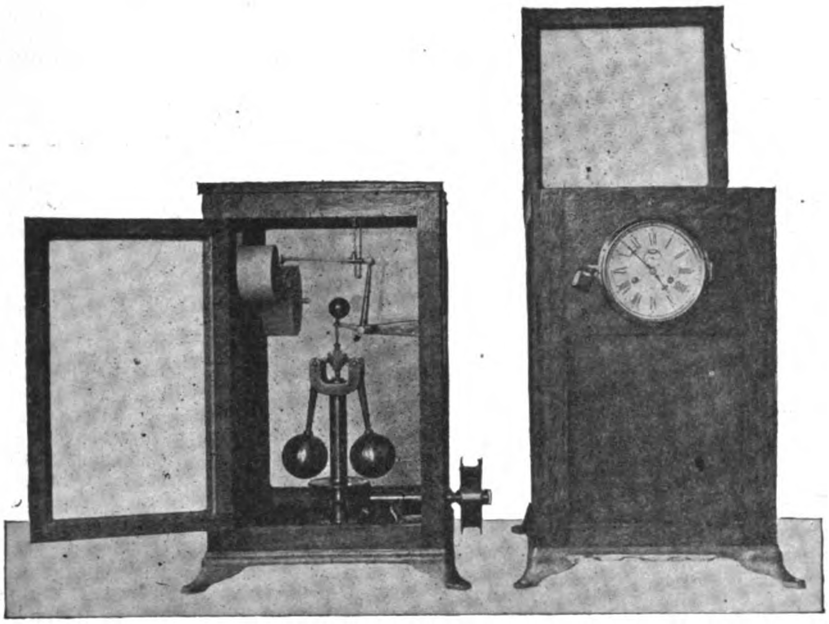
The current consumed by each clock is about 7 watts. The clock is started by means of the milled nut A, which is connected directly to the star-shaped armature.

THE NEW LOMBARD SPEED RECORDER.

THERE is no one thing about an electric station which is of more importance than to know when machinery starts, when it stops, and what its exact speed was at every moment when it was running. An exact knowledge of the above facts answers many perplexing questions in the engineering department, and also enables the manager to talk with perfect confidence to irritable customers who relate exaggerated accounts of faulty light or power service due to "shut downs" or variable speed

To meet the above want the Lombard Water Wheel Governor Company, of No. 61 Hampshire street, Boston, Mass., has placed on the market a speed recorder, which is shown in the accompanying cut. This instrument illustrated in Fig. 1 leaves little to be desired in the way of sensitiveness, accuracy, and reliability. It is strongly built, beautifully finished and is reasonable in price. A photographic reproduction of the paper strip used with this instrument is shown in Fig. 2. It will be seen that the speed, corresponding to each longitudinal line, is printed on the paper so that there can be no mistake in reading the speed correctly; these figures are printed at six-inch intervals. At the upper edge of the paper strip numbers from 10 to 60 are printed. These indicate minutes, and at the beginning of each hour the pencil marking the record of speed stands directly over the line marked 60. The paper is fed forward, from left to right, the distance between each vertical line, every five minutes, and by writing the hour on the line marked 60 the time of any speed variation during the day may be readily found. The feed motion is positive so that there is no possibility of the record on the paper strip not corresponding with the time indicated by the clock.

This instrument was not originally gotten up to sell, but was intended purely for the experimental work of the Lombard Water Wheel Governor Company, but so many persons who had seen this speed recorder at work expressed a desire to purchase one that it was decided to build them in commercial quantities. It is not often that a machine is made which will sell itself, but it is a fact that before the first lot of these speed recorders were finished they were all sold, and that without any solicitation on the part of the manufacturer. From this fact it would seem that these machines fill a popular want.



Side View with Door Open. Front View with Top Open.

FIG. 1.—THE LOMBARD SPEED RECORDER.

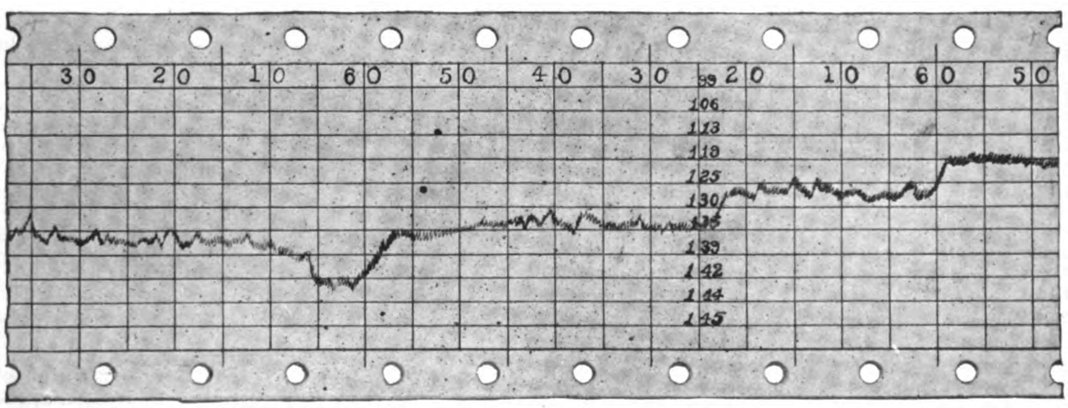


FIG. 2.—RECORD MADE BY THE LOMBARD SPEED RECORDER.

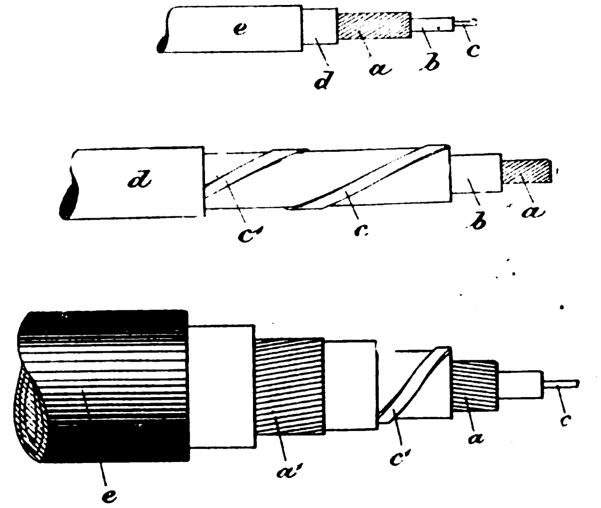
GUILLEAUME'S INSULATED WIRE CABLE.

IN the equipment of coal mines with electric light and power transmission great care is taken, in the case of gaseous mines, to avoid the generation of sparks, which might ignite the fire damp and thus cause explosion. These precautions have heretofore been confined exclusively to obtaining sparklessness at the machines in the pits, but it is evident that danger still lurks in the conductor itself, which may be ruptured, and thus create an arc. It is with the object of providing for this contingency that Mr. Theodore Guilleaume, of Mülheim-on-Rhine, Germany, has devised several types of cable which are illustrated in the accompanying engravings.

According to one mode of construction, illustrated in Fig. 1,

the cable comprises a main conductor, a, surrounding a safety-conductor, c, but separated therefrom by insulating material b; d, is another insulating-covering and e, an outer protective covering. The main conductor, a, is made of copper or other ductile metal and the safety-conductor of steel, bronze or other metal which, unlike the soft and ductile copper, will bear comparatively little elongation without breaking. In the event of the cable being subjected to excessive tensile strain the independent current traversing the safety-conductor, c, is first interrupted in consequence of that conductor breaking, the effect being that the main current is diverted from the principal conductor, a, before the latter breaks.

Where there is reason to apprehend crushing, the cable is



FIGS. 1, 2 AND 3.—THE GUILLEAUME SAFETY MINE CABLE.

constructed as illustrated in Fig. 2. In this instance the safety-conductor, c c', in the form of a bipart steel tape, is wound round the insulated copper conductor, a, in a coarse-pitch double spiral. Where such a cable is liable to damage from concussion or crushing only (as distinguished from excessive tension) the main and safety conductors are, respectively, made of metal of equal ductility; but when it is desired to provide in addition against the effect of tension the safety-conductor is composed of metal having less ductility than that possessed by the main conductor.

The above described arrangement may be adopted in connection with cables composed of several conductors, in which

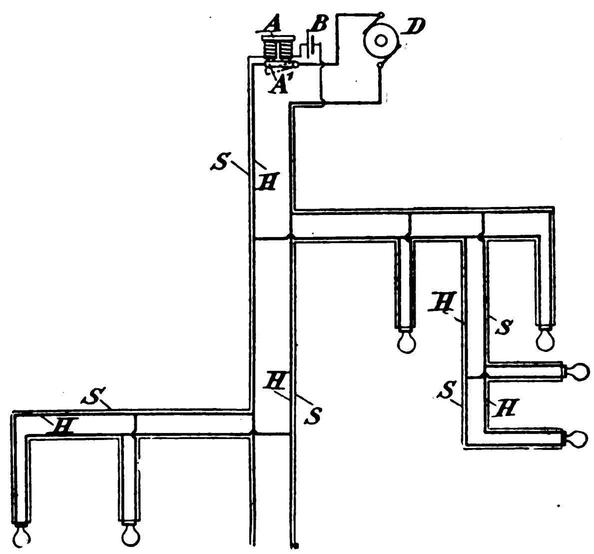


FIG. 4.—THE GUILLEAUME SAFETY MINE CABLE.

case the cable must be provided with at least two safety-conductors. These latter may assume the form of a pair of conductors in the center of the cable, as shown in Fig. 1, or as indicated in Fig. 3, but the most advantageous arrangement of the safety-conductors is shown in Fig. 4, where one of the safety-conductors, c, is in the center of the cable, while the other, c', in the form of a metallic tape, occupies a position either between the inner main conductor, a, and the outer main conductor, a'.

The method of connecting a cable such as described with reference to Fig. 1 is illustrated in Fig. 3, D representing the dynamo supplying current to the main circuit, H, B the battery supplying current to the safety-circuit S, and A A' the switch device adapted, on the interruption of the safety-circuit, to intercept communication through the main conductor.

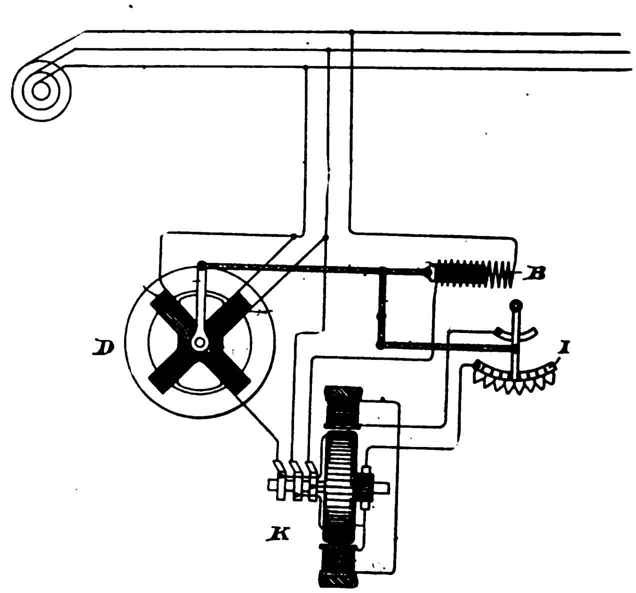
Throughout the line all the safety wires, c, Fig. 1, are included in one circuit, S, to which current is constantly supplied by the battery, B, this current being just strong enough to retain the armature A of the switch or "cut-out" in position for enabling the other or more powerful current to traverse the main circuit H. When the safety-current is interrupted the armature, A' being no longer attracted, falls away and instantly effects the interception of the main circuit H. Thus, when a cable, forming the main electric line, is strained to a point threatening it with rupture the safety-wire c, being less ductile than the main conductor a, breaks, interruption in the main circuit H ensuing before the copper conductor a itself breaks.

BERG'S METHOD OF REGULATING THE PHASE OF ALTERNATING CURRENTS.

IT is well known that the most efficient operation under ordinary circumstances is obtained for alternating-current systems of distribution when the current and electromotive force in the circuit are in phase. Mr. Ernst J. Berg, one of the engineers of the General Electric Company, has devised an arrangement of apparatus which will respond to a difference of phase between the current and electromotive force, and by such response will tend to correct the distortion of phase between the two power elements in the circuit.

Mr. Berg employs a synchronous motor, K, connected between the lines of the system of distribution. To control the excitation of this motor an ordinary resistance, I, is used, and to control the amount of resistance in circuit with the field the rheostat is connected to a solenoid, B, influenced by the amount of current passing to the synchronous motor.

Opposing this current device is a watt mechanism, D, so that when the current is in phase with the electromotive force



BERG'S METHOD OF PHASE REGULATION.

the power exerted by the watt mechanism is balanced by that of the current-actuated device, and the resistance will not be changed. When, however, the current lags, it becomes larger, and therefore the current-actuated mechanism, B, acts with more force than the watt mechanism, which depends upon the relation between the current and electromotive force for its energy. The amount of resistance is then changed, the excitation of the synchronous motor is altered, and its effect upon the lines between which it is coupled is so varied as to restore the phase relation of the current.

EDUCATIONAL.

UNIVERSITY OF NEBRASKA.

The new Chancellor of the University of Nebraska, Dr. G. E. MacLean, was inducted into office on Feb. 14, at the University, Lincoln, Neb. The ceremonies were attended by large numbers of people from all over the state, from the Governor down, and from many parts of the Union. A special feature of interest to electricians was the large share in the various proceedings assigned to the electrical engineering students at the University, under the direction of Professor R. B. Owens, who has that department in charge. On the evening of Feb. 13, Mr. T. C. Martin lectured before the University and visitors on the "Development of Power at Niagara Falls." After the inauguration, a fine exhibit was given in the gymnasium of the latest things in electricity, including calcium carbide, cathodographs, cooking, heating, welding, etc., and the attendance was enormous, thousands of people inspecting the admirable display as well as the engineering buildings, and equipment. On the tower of the main University Building, the electricals erected a large Franklin kite, framed in lamps, from the base of which a long tail, also made up of lamps, was strung across the campus to a pole. By means of a commutator, current was continually flashed over the kite and up and down the tail, with most brilliant and startling effect. It is needless to say that the electricals covered themselves with glory. Although the new Chancellor, Dr. MacLean, is not closely associated with physical or engineering pursuits, his previous post having been that of Professor of English Literature at the University of Minnesota, his profoundly able inaugural address showed him to have deep sympathy with such studies, and the prominence allowed to electricity upon so important an occasion is fitly regarded not only as a great compliment, but an earnest of liberal support and encouragement for electrical engineering at the hands of the governing body.

"HOME STUDY."

In connection with their courses of work in the International Correspondence Schools, the Colliery Engineer Company of Scranton, Pa., are now publishing an admirable periodical manual or text book which they call "Home Study." It is full of excellent data for the use and benefit of those who are employing their leisure in study of mathematics, engineering, physics, etc., and cannot but be extremely helpful to all who engage in the praiseworthy effort of self-improvement. The paper is neatly and handsomely printed, and is a credit to the publishers.

SOCIETY AND CLUB NOTES.

A BROOKLYN SOCIETY OF ELECTRICIANS.

We learn that a movement is being actively pushed in Brooklyn to establish a local society of electricians, whose chief objects will be to draw together practical men and to open a place of meeting equipped with books, apparatus, etc., It is proposed to divide the membership into two classes, associate and active. The latter will comprise those who possess a thorough knowledge of the science; the former class will include those generally identified with electrical and kindred work. The divisions will be strictly adhered to. The initial meeting will be held at 17 Whipple street, Brooklyn, on Feb. 28, at 8 P. M., to adopt a constitution and elect officers. We are informed that many men are already enrolled, all the Brooklyn central stations being represented in the list of membership.

HENRY ELECTRICAL CLUB.

At a meeting of the Henry Electrical Club, held on Feb. 14, Mr. H. T. Wade, of Columbia College, lectured on "Measurement of Resistance." Considering the subject under the divisions of high, medium, and low resistances, Mr. Wade described various means employed in taking measurements, and explained the conditions met in dealing with each class. Describing the Wheatstone Bridge, he entered very fully into its theory, and gave formulas showing the best proportions of its parts under given conditions. The determination of specific resistances of metals, with the precautions taken to eliminate errors, were clearly explained. In the measurement of insulation the lecturer fully described the method of direct deflection, with the manner of taking a constant; and he pointed out the disturbing factors in cable testing.

Mr. Wade's lecture, while comprehensive in its treatment of the subject, was noteworthy in its avoidance of description of any but the most modern and approved practice.

AMERICAN INSTITUTE OF ELECTRICAL ENGIEEERS.

The nomination blanks for the ticket of the American Institute of Electrical Engineers have been issued, and are now in the hands of the members. A number of the friends of Professor F. B. Crocker, of Columbia College, are filling in his name, for the presidency. It would certainly be difficult to make a better choice. Professor Crocker has already served the institute in various capacities and has done a large amount of hard work, particularly on the committees of editing and papers. The honor will be well bestowed, should he be elected.

The 103d meeting of the Institute will be held at 12 West 31st street, on Wednesday, Feb. 26, 1896, at 8 o'clock P. M. As already announced by a notice framed by the Committee on Incorporation to comply with the laws of the State, the first business of the meeting will be the consideration of a proposition to incorporate the Institute. The discussion of the paper by Mr. Frank J. Sprague on "Electric Elevators, Their Uses and Advantages," will be taken up in accordance with the action at the last meeting. The postponed discussion will be reopened by Dr. Cary T. Hutchinson.

NEW YORK ELECTRICAL SOCIETY.

On the invitation of the Edison Electric Illuminating Company, of New York, the next meeting of the society will be held at their station, 57 Duane street, on Thursday, Feb. 27, at 8 P. M. On this occasion Mr. John W. Lieb, Jr., the president of the society, will deliver an address on "The Generation and Distribution of Current by an Edison Station." By the courtesy of the company the station will be thrown open for the inspection of the visitors. Members are requested to notify the secretary of the society, at 203 Broadway, not later than Wednesday, the 26th inst., of their intention to be present, in order that proper arrangements for their reception may be made.

REPORTS OF COMPANIES.

THE WAGNER ELECTRIC MANUFACTURING COMPANY.

The Wagner Electric Manufacturing Company, of St. Louis, Mo., has been incorporated since August, 1891, and since that time its business has increased from $10,000 to a business of $200,000 a year. This progress is regarded as not only due to the exhaustive work of the managing department, but to the very superior line of articles manufactured. All articles that were placed on the market within this period have been considered to be of the very best in their respective lines, and standard from the point of efficiency and durability.

In August, 1893, the company was compelled to move to its present quarters, at 2017 and 2023 Olive street, from its old factory at 1822 Olive street. It then had a capital of $25,000. The daily improvement of business demanded its increase, which was duly made to $100,000. Since then to the present time it has gradually increased to the present maximum in sales, of $200,000 annually, and finds its quarters entirely inadequate for their purposes. In December last it was found important to enlarge the manufacturing facilities in order to take care of the demand for its specialties. The three-story factory, which it owns and now occupies, covers a ground space of 45x70 feet. In front of this building the company proposes to erect a building which will cover a lot 125x70 feet. The building will be seven stories high when finished.

For the purpose of this work it was necessary to increase capital stock. At a meeting of the stockholders, held on the 17th inst., it was unanimously voted to increase the capital stock from $100,000 to $250,000, and at the Board of Directors meeting, held on the 18th, it was decided to begin the erection of the new building at once on the plans submitted for approval. The additional floor space will permit of tripling the present output, and the company will then begin to manufacture more extensively its recognized high grade specialties, for which in a short time it will be in the field soliciting orders.

Of late the company has been working overtime, and in fact two shifts during part of the winter, but even then was compelled to turn down some orders which it could not handle on account of the brief time set for their shipment. It is in a better position now to fill orders, as the buying has moderated considerably, and, in fact, can fill orders for motors, transformers, generators, etc., within a reasonable time from their receipt. The general outlook remains excellent.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS, ISSUED FEB. 18, 1896.

Alarms and Signals:—

ELECTRICALLY OPERATED RAILWAY TRACK SWITCH. F. H. Harriman, Hartford, Conn., 554,868. Filed Dec. 11, 1895.
Means for electrically operating a track switch with current from the line wire.

MANUALLY CONTROLLED ELECTRIC BLOCK SIGNAL SYSTEM. A. G. Leonard, New York, 554,884. Filed July 26, 1894.
Comprises a rocking spindle, a plunger, a circuit closer and a swinging bar or plate under the control of the rocking spindle to prevent or permit the action of the plunger.

FIRE ALARM TELEGRAPH SYSTEM. J. F. Mehren, Chicago, Ill., 554,889. Filed April 4, 1894.
A system having two main lines over each of which every signal is transmitted.

ELECTRIC CIRCUIT CLOSER AND BREAKER. J. R. Farmer, St. Louis, Mo., 554,918. Filed May 25, 1894.
A means for closing and breaking the electric circuit used in connection with electric signal lamps.

SAFETY SYSTEM FOR RAILROADS. B. C. Rowell, Boston, Mass., 554,957. Filed Sept. 4, 1894.
The combination of an automatic electrical locking device locked by the presence of a train on any section and locking the locking bar which controls the bolts of the locking apparatuses.

Conductors, Conduits and Insulators:—

INSULATOR. E. Peloubet, Alexander, Ark., 554,723. Filed Nov. 1, 1895.
A base of metal with openings therethrough, one of which has a communicating slot and glass insulators in said openings.

INSULATOR FOR ELECTRIC WIRES. M. Riera, Havana, Cuba, 554,955. Filed Sept. 5, 1895.
Incloses two clamp members so as to inclose between them a substantially prismatical space and an elastic filling held in said space and apertured for the reception of the wire.

Dynamos and Motors:—

INDUCTION MACHINE. W. K. Freeman, Fort Wayne, Ind., 554,670. Filed July 5, 1895.
A dynamo involving a compact structure, in which a magnetic circuit is secured with a minimum air-gap between the field and armature core.

Electrolysis.—

PROCESS FOR PRODUCING LAKES OF COLORING COMPOUNDS BY ELECTROLYSIS. R. McKenzie, Jersey City, N. J., 554,718. Filed Feb. 21, 1895.

Electrometallurgy:—

ORE-CONCENTRATOR. J. O. Dimmick and E. K. Woods, Denver, Colo., 554,914. Filed April 27, 1895.
Means for arresting and separating the metallic portion of pulp as the same, in a granulated or pulverized form, is forced by means of water over the concentrator bed.

Lamps and Appurtenances:—

KEY SOCKET FOR INCANDESCENT LAMPS. B. W. Snow, Syracuse, N. Y., 554,896. Filed Jan. 2, 1895.
Details of construction involving an insulated base.

Lighting System:—

LIGHTING CARS. W. F. Hutchinson, New York, 554,697. Filed April 15, 1895.
The combination with the car and the revoluble screw on the car track, of the generator on the car, and a train of gearing connecting the generator with the screw.

ELECTRIC LIGHTING SYSTEM. E. L. Slocum, Pawtucket, R. I., 555,057. Filed April 3, 1893.
Consists in the employment of an automatically operated mechanism provided with a plurality of electric contact points for closing and breaking the electric circuit, so as to cut successive batteries in and out.

Miscellaneous:—

GAS LIGHTING SAFETY APPLIANCE. F. and F. H. Engelhard, Springfield, Mass., 554,665. Filed June 3, 1895.
A source of electrical energy, a series of conductors, a gas burner, an induction coil and a make-and-break mechanism governed by clock mechanism.

HEAT REGULATOR. E. Frischnecht, New York, 664,671. Filed March 9, 1895.
Consists substantially of a thermometer, an electric motor operating a heat regulator, an electric circuit, extending from the thermometer to the motor, and an adjustable contact included in said circuit.

LAUNDERING APPARATUS. D. Reynolds, Evansville, Ind., 554,795. Filed Dec. 15, 1894.
The water is subjected to electrolysis.

ELECTROMAGNET. J. Houlehan, Chicago, Ill., 554,821. Filed May 10, 1895.
Provides a construction of electromagnet whereby dead centers on the pole pieces shall be prevented.

MEANS FOR RECORDING AND REPRODUCING IMPULSES. W. H. Cooley, Brockport, N. Y., 554,862. Filed April 16, 1889.
A recording surface and means for producing undulations in an electric current caused to pass therethrough.

ELECTRIC HEATER, RESISTANCE, OR RHEOSTAT. P. B. Delaney, South Orange, N. J., 554,910. Filed June 7, 1892.
The heating or resistance conductor is strung through buttons of fireproof insulating material.

Primary Batteries:—

ELECTRIC BATTERY. C. Willms, Baltimore, Md., 554,759. Filed May 3, 1893.
Consists of a number of small dry cells, which may readily be placed in and removed from their support in the battery.

ELECTRIC BATTERY. C. Willms, Baltimore, Md., 554,760. Filed Jan. 19, 1894.
Details of construction of a chloride of silver cell.

ELECTRIC BATTERY AND METHOD OF SEALING BATTERY CELLS. C. Willms, Baltimore, Md., 554,761. Filed July 12, 1894.
Relates to a chloride of silver cell.

GALVANIC BATTERY. E. L. Slocum, Pawtucket, R. I., 555,056. Filed July 2, 1894.
A means for automatically amalgamating the positive electrode.

GALVANIC BATTERY. E. L. Slocum, Pawtucket, R. I., 555,058. Filed March 28, 1893.
Combination with the carbon electrode and the zinc electrode, of an insulator surrounding the zinc electrode on all sides within the exciting fluid.

Railways and Appliances:—

TROLLEY SUPPORT. F. E. Homer, Cleveland, Ohio, 554,694. Filed Nov. 30, 1894.
Spring tension suspended trolley pole support, in which the degree of the tension will remain nearly uniform.

CONDUIT ELECTRIC RAILWAY. W. Osterlein, Cincinnati, Ohio, 554,719. Filed Sept. 21, 1894.
A metallic current conducting rail and its supports in a tunnel between the tracks of the railway and a traveling contact device for taking the current through the motor upon the car.

RAIL BOND FOR ELECTRIC RAILWAYS. R. C. Brown, Somerville, Mass., 554,859. Filed March 21, 1894.
Comprises a hollow plug inserted through each of the rails, and a tie-wire extended through said plugs.

RAIL BOND FOR ELECTRIC RAILWAYS. S. Nikoloff, Worcester, Mass., 554,949. Filed Jan. 2, 1896.
Comprises an outer cylinder joined at one end with an inner cylinder axially concentric and parallel therewith, and having an annular intervening space for the reception of a tubular key or expander.

ELECTROMAGNETIC INDUCTION SYSTEM OF PROPULSION. A. C. Shuttleworth, Philadelphia, Pa., 554,962. Filed Feb. 7, 1895.
Employs an alternating or interrupted current traversing a stationary primary conductor in inductive proximity to a moving secondary conductor, and also stationary parts of a magnetic circuit and moving parts of a magnetic circuit.

Telephones:—

TELEPHONY. F. R. Colvin, New York, 554,656. Filed Nov. 24, 1894.
Provides a system of intercommunication for a plurality of subscribers, by which the advantages of a round metallic circuit with a minimum amount of self-induction may be afforded.

ELECTRICAL CONNECTING CORD. C. H. McEvoy, Lowell, Mass., 554,716. Filed May 15, 1895.
Comprises two covered conductors, inclosed in a common covering and projecting from the ends thereof, and one or more suspension cords, arranged in said covering.

TELEPHONE. W. H. Russell, New City, N. Y., and G. E. Russell, Little Falls, N. Y., 554,895. Filed Aug. 10, 1895.
Combines in one the instrumentalities of a carbon transmitter and a magnetic receiver.

PERSONAL.

MR. HARVEY MIDDLETON, manager Pullman Car Works, having tendered his resignation, the same has been accepted. Until further notice the present assistant managers, A. M. Parent and Frederick Wild, will have immediate charge of the Pullman Car Works, and will report to the general manager direct.

MR. LUDWIG GUTMANN has accepted the position of electrical engineer with the Royal Electric Company, of Peoria, Illinois.

MR. WALTER C. M'KINLOCK, Secretary of the Metropolitan Electric Company, has the sincere sympathy of all of the electrical fraternity at the death of his baby boy last Saturday.

MR. DINSHAH PESTONJEE GHADIALLY is a recent visitor to this country from India, where he held until recently the position of electrician to the Maharajah Rana Sahib of Dholpur, a native principality between Agra and Gwalior. Mr. Ghadially is on a trip around the world inspecting for his own information all the various electrical plants along his route.

MR. S. G. BOOKER, superintendent of the Phœnix Carbon Manufacturing Company, St. Louis, Mo., was a visitor to Chicago last week.

MR. C. H. WILMERDING, president of the National Electric Light Association, was in New York last week in active consultation with Mr. Porter, secretary of that body, and the officials of the exposition. He found the outlook for a large meeting and a fine exposition of the most brilliant and encouraging nature.

LEGAL NOTES.

A PRIORITY CLAIM ON LIGHTING BUOYS.

Wm. R. Wood, of Scotland Neck, ex-superintendent of the Insane Asylum at Raleigh, N. C., has brought suit to recover half a million dollars damages from the United States Government for infringement upon his patent for electrically lighting buoys. He obtained a patent in 1876, and in 1888 the Government suddenly adopted his system. The case comes up in the Court of Claims this spring.

ELECTRICITY FOR NEW YORK CANALS.

Senator Lamy has introduced a bill in the New York Senate authorizing Superintendent Aldridge, of the Public Works Department, to expend $500,000 for the equipment of the canals of the state with electrical motive power.

Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

POETRY AND PAINTS.

With the coming of each and every spring, editors and publishers are offered "Spring Poetry," which is considered by the authors, of a quality quite equal, if not superior, to anything ever launched upon the poetry-loving world. As with poetry, so it is with paint—as the spring season of painting and repainting comes along there is sure to be offered something new in the way of paint mixture for the protection of roofs, iron work, etc. Fortunately the public, as a rule, discriminates as wisely against such new nostrums as it does in its poetry, and rightly chooses a paint like Dixon's Silica Graphite Paint, which has been so favorably known for over a quarter of a century.

Roofs painted with Dixon's "Silica Graphite" Paint have not required repainting in twelve to fifteen years and over. Railway and other corporations known for their thorough testing and careful selection of materials, use this paint in large quantities.

Any one desiring to know more about Graphite Paint should address the Joseph Dixon Crucible Company, Jersey City, N. J.

THE STANDARD WATER TUBE SAFTY BOILER.

The Standard Boiler Company, 1120 and 1121 Marquette Building, Chicago, Ill., claim that the superiority of their boiler over the ordinary type lies in its economy in the use of fuel, its freedom from possible explosion, its perfectly free and unrestricted circulation, and the ease with which any part may be examined for cleaning and repairs. The purifying chamber is a peculiar feature of the boiler, which has been designed for the exigencies of the Western trade. The large quantities of impurities in the water throughout the Middle and Western states necessitates the use of a means of purification at once simple and effective. This is exactly what the purifying chamber affords, they say. It gives the benefit of a live steam feed water purifier at a slight additional cost, and reduces the scale formation in the boiler to a minimum, keeping the tubes and the whole interior clean, and consequently increasing the efficiency of the heating surfaces, as well as the saving of fuel.

M'INTOSH, SEYMOUR & CO.'S RECENT WORK.

Among the recent orders received by Messrs. McIntosh, Seymour & Co. is one from the Columbian and Maryland Railway Company to build them eight engines of 1,000 horsepower each, that will couple direct to 700 kilowatt Westinghouse generators.

They are also making two 1,200 horsepower, 800 kilowatt, direct coupled engines for the City and Suburban Railway Company of Baltimore, Md., making six sold that company. Other orders include two 1,200 horsepower, 800 kilowatt direct coupled engines for the Cincinnati Street Railway Company, making fourteen sold that company; two 1,200 horsepower engines for the Municipal Electric Light Company, of Brooklyn, N. Y., and one 1,000 horsepower cross-compound vertical engine for the Atlantic Mills of Lawrence, Mass. The above are sales for slow-speed engines since Jan. 1, 1896.

McIntosh, Seymour & Co. are also making a 700 horsepower, three-cylinder, three-crank vertical engine, direct connected to two 200 kilowatt dynamos, for Buenos Ayres, Argentine Republic.

In addition they are busy on a lot of orders for their regular high-speed engines.

THE UNITED STATES TELEPHONE CONSTRUCTION CO.

The United States Telephone Construction Company, of Philadelphia, have moved their offices from the Bullitt Building to very handsome quarters in the Philadelphia Bourse. They have also largely increased their capital and are going into the telephone business on a much larger scale than heretofore, their plan being to organize state or subcompanies to cover the entire United States, and allow these companies to manufacture their own instruments when desired, thus giving each subcompany all the manufacturing profit and an opportunity to meet all local requirements. The management assert that if the Berliner patent is sustained by the United States Supreme Court, this company, "owning and controlling the method patent for a make and break telephone, will be practically the only opposition the Bell Company will have." They will make five styles of telephones and guarantee each and every one of them to be absolutely non-infringing in every particular. Their new long-distance 'phone is guaranteed to talk over 5,000 miles of resistance.

THE WASHINGTON ELECTRIC CO.

The Washington Electric Company, of Chicago, have removed from their old quarters at 205 and 207 South Canal street to the new Russell Building, 31-45 W. Randolph street. The business of this company has had such a rapid increase during the past few months that the facilities for manufacturing in the building which they have just vacated were utterly inadequate to permit them to execute their orders on time, and the change has been in every sense a most desirable one. The space which this concern have secured is at least twice as large as they had before, and comprised a large factory and fine general office; also a private office for the use of Mr. W. A. Meissner, the president and manager of the company. The factory is equipped with the newest and most improved machinery necessary for the manufacture of the electrical goods which they turn out. It is very lofty, has a southern aspect, and a very large window space which gives fine light throughout the entire place.

BERLIN IRON BRIDGE COMPANY.

The Berlin Iron Bridge Company, of East Berlin, Conn., have a contract for a steel floor to be placed in one of the buildings of the Alexander Smith & Son's Carpet Factory, at Yonkers, N. Y. They also have a contract for furnishing the ironwork for Meara Bros.' new block at Torrington, Conn. This block is three stories high and the girders are placed in the ceiling of the first floor and made sufficiently strong to support the two upper floors. The top floor is a dancing hall and the structure has been made with the view of making the building as stable as possible, and avoid any danger of vibration caused from the use of the dancing hall on the upper floor.

STANDARD PAINT AGENCY FOR "SHIP" CARBONS.

The Standard Paint Company, No. 2 Liberty street, New York, the well-known manufacturers of the better known P. & B. goods, have accepted the agency for the United States and Canada of the celebrated "Ship" Carbons, manufactured in Vienna by Messrs. Schiff, Jordan & Co. Electricians are already familiar with these well-known carbons, they having been handled here for some little time by Mr. Frank S. De Ronde. While the business will be continued by the Standard Paint Company, Mr. De Ronde will give it his special attention, and look after the same as heretofore. The company have arranged to carry a very large stock of these goods in New York at all times so as to be prepared to make prompt shipments. The carbons are claimed to be of the very highest order, and give a steady, brilliant light at a minimum current without dust, noise or hissing. The importers will willingly send samples gratis on application. It will pay all those interested to at once correspond with the Standard Paint Company, who up to April 15 will be at the old stand, No. 2 Liberty street. After that date they will occupy their new and larger quarters at 79 and 81 John street, necessitated by the steady and growing demand for the P. & B. products.

FLUORESCING SALTS FOR ROENTGEN X-RAY EXPERIMENTS.

The universal interest displayed by physicists in Röntgen's recent discovery has developed an unprecedented demand for the salts of platinum, which fluoresce under the impact of the X-rays. Messrs. Baker & Co., the Platinum refiners, of Newark, N. J., inform us that they have sold more of the particular salt recommended by Röntgen as most suitable for X-ray experiments, namely, Barium Platino Cyanide, than ever before in the history of their business, and that in consequence of the undiminished demand for this salt they have been obliged to increase their laboratory force.

THE ELECTRIC APPLIANCE COMPANY have been pleasantly surprised at the way in which their wire sales have held up since the first of the year. It is usual to look for quite a falling off in this material after Jan. 1, but the demand for both "O. K." Weather-proof wire and Paranite Rubber-Covered wire has been exceptionally good, much to the satisfaction of both the manufacturers and the Appliance Company.

THE CUTTER CO. OF PHILADELPHIA.

The Cutter Electrical and Manufacturing Company takes pleasure in announcing that the assignment made in August last has been dissolved, and that with largely increased capital, it will continue its business, as heretofore. The company will devote special attention to the manufacture of its C. S. flush switches and the I. T. E. automatic magnetic circuit breakers. The demand for "Circuit Breakers" is already taxing the present capacity of its factory.

GREEN'S ASBESTOS INSULATING PAPER.

The constant increase in the potentials employed in practice in electrical distribution makes the question of the proper insulation of armatures more and more important. Asbestos has long been recognized as of value on account of its insulating, and especially on account of its fireproof qualities, when the material employed was pure. But the difficulty heretofore has been to secure the necessary purity and the making up of the asbestos in shape suitable for general application to armature insulation. A product combining both of these essential features is the asbestos paper now being placed on the market by the Asbestos Insulation Company, of Baltimore. This paper, which is the invention of Mr. John F. Green, the president of the company, is prepared by first subjecting the asbestos fiber to a chemical process which extracts from it all the impurities of iron, copper, or other metallic particles. The purified fiber is then applied to a base of prepared manilla paper, resulting in a product which is eminently adapted to insulation of dynamos, converters, etc. Prepared in this way the asbestos paper has a thickness of only .009 inch, while it is hoped shortly to reduce even this to .006 inch.

Tests of this insulating paper .0085 inch thick have shown it to withstand puncture at 1,800 volts, while eight sheets, of a total thickness of .065 inch, withstood a strain of 7,600 volts. The influence which such an insulation may have on the economical construction of machines must be apparent. It goes without saying that no amount of heat to which this insulation can be subjected has any effect on its insulating property.

The company expects shortly to place on the market an insulating paper which shall be both fire and water proof. It is also contemplated to apply this asbestos paper to the insulation of wires, and experiments to that end are now under way. Messrs. Green & Seaman, of 23 S. Charles street, Baltimore, are the selling agents for the Asbestos Insulation Company.

ADVERTISERS' HINTS.

THE NATIONAL ELECTRIC EXPOSITION, to be held in this city during May, in connection with the convention of the National Electric Light Association, is now an assured success. Already the greatest interest and a desire to co-operate with the management has been manifested by manufacturers throughout the country. The first allotment of space will be made March 10.

THE WASHINGTON ELECTRIC COMPANY, of Chicago, have found their former quarters inadequate to the demands of their constantly growing business, and are now located in the Russell Building, that city.

THE CUTTER ELECTRIC AND MANUFACTURING CO. continues to advertise the "I. T. E." automatic magnetic circuit breakers, and they say their customers help them in doing so.

THE RUSHMORE DYNAMO WORKS manufacture photo-engraving lamps of from 1,000 to 40,000 candle-power and searchlights up to 100,000,000 candle power. A great many of their lights are now in use and their reliability makes them very popular.

THE HOLMES FIBER-GRAPHITE COMPANY are selling a commutator brush that deserves the attention of central station men.

TH INDIA-RUBBER AND GUTTA-PERCHA INSULATING COMPANY have something to say about X-rays and "looking into things."

THE BAECHTOLD & PARKER COMPANY are headquarters for everything in the way of electrical supplies.

THE BRISTOL COMPANY report business brisk and daily improving in the sales of their recording instruments.

THE STANDARD PAINT COMPANY are now the United States agents for Schiff, Jordan & Co.'s "Ship" cored carbons. They continue to supply the large demand for the S. & B. specialties.

THE MORRISON-SOUTHERN ELECTRIC COMPANY illustrate a flush switch they have recently placed on the market, which is simple in construction, efficient in operation, and cheap to install.

NEW YORK NOTES.

THE BARRIETT ARMATURE WINDING COMPANY has been formed by W. J. Quencer, A. B. Quencer and H. W. Thounard, with a capital stock of $10,000. Mr. Barriett has established a shop to carry on this special work in New York City.

THE DIRECT CURRENT TRANSFORMER COMPANY, of New York City, has been formed by A. D. Warren, P. B Welsh and W. A. Spellman, of New York City, and F. D. Goold and George Stanmore, of Brooklyn. The capital stock is $60,000.

THE ELECTRIC SIGN AND NOVELTY COMPANY has been formed to manufacture signs, with a capital stock of $250,000. The incorporators are E. O. McCook, of Dobbs Ferry, N. Y.; T. Orgell, of Brooklyn, and F. Beckbane, of Newark.

RUETE CONDUITS.—The Interior Conduit and Insulation Company has acquired control of the Ruete patents and system for making iron armored insulated conduit, and will introduce many improvements in its well-known specialties in that line. Mr. E. T. Greenfield resumes his connection with the Interior Conduit Company.

THE A. B. SEE MANUFACTURING COMPANY, of Brooklyn, N. Y., have purchased a lot of land about 200 feet long by 102 feet wide, on Pearl street, Brooklyn, extending from Front street to Water street, and will at once commence the erection of a six-story building. Their present quarters, which are in the immediate vicinity, are much overcrowded with work, and altogether inadequate for their rapidly growing business.

A. O. SCHOONMAKER, of 158 William street, New York, who is always ready to meet the demands of the trade, is now offering his Solid Sheet Mica Segments built up to required thickness ready for use. If our readers have any special pattern they want, he is ready to cut it.

WESTERN NOTES.

THE METROPOLITAN ELECTRIC COMPANY are putting on the market a double coil filament incandescent lamp for street car use. This lamp is found to give unusual satisfaction for this class of work, as it resists jarring, the filament will not break, and the lamp is long lived, without any appreciable blackening effect.

THE PACKARD ELECTRIC AND MANUFACTURING COMPANY, of Warren, O., has been formed, with a capital stock of $110,000.

THE TRIUMPH COMPOUND ENGINE COMPANY, of Cincinnati, has changed its name to the Triumph Electric Company, and has increased its capital stock from $75,000 to $125,000.

THE METROPOLITAN ELECTRIC COMPANY have just gotten a large stock of baby and large knife switches from Eyanson & Armprister, Philadelphia, for whom they are general Western agents.

N. I. R. wire has been specified in several large installations lately, and the Metropolitan Electric Company carry a large stock on hand and sell this wire in the West. Customers say it gives perfect satisfaction.

MR. J. H. M'GILL, who has recently been appointed Chicago manager of the Ohio Brass Company, Mansfield, O., in place of Mr. Max A. Berg, who is now at the head office and works of this company, has moved his office from 1533 the Monadnock Block, Chicago, to 1129-1130 the same building. Mr. McGill also takes care of the Chicago business of the Peru Electric Manufacturing Company, of Peru, Ind.

MR. M. B. AUSTIN, Western representative of the Safety Insulated Wire and Cable Company, New York, and Holmes, Booth and Haydens, Waterbury, Conn., has also removed from his old address, 1533 the Monadnock, to rooms 1129-1130, where he and Mr. J. H. McGill are now settled in a handsome set of offices where they will be pleased to receive calls from their many friends.

THE DETROIT ELECTRICAL WORKS are to be sold at Detroit on March 4, the property including the factory, machinery, manufactured goods, bills receivable, and 46 letters patent, some of which are regarded as being of considerable importance. The trustees are Louis Warfield and W. A. Jackson.

MR. J. R. WILEY, manager of the Chicago office of the Standard Underground Cable Company, of Pittsburg, recently made a business trip and reports that the amount of orders they are receiving is highly satisfactory and that they are kept hard at work all the time.

Department News Items will be found in advertising pages.

THE
Electrical Engineer.

Vol. XXI. MARCH 4, 1896. No. 409.

ELECTRIC LIGHTING.

WESTERN ELECTRIC IRON CLAD ARC DYNAMOS.

REALIZING that the ironclad armature has almost completely driven the surface wound machine from the market, in constant potential work, the Western Electric Company has designed and put in service a complete line of arc machines having ironclad armatures and other new features.

These ironclad armatures have been in use in increasing numbers for over a year without the loss of a single coil. This is a practical demonstration of the possibility of insulating an ironclad armature for high voltages, and once having accomplished that task, the mechanical superiority of the ironclad armature is unquestionable. The man who has spent twice as much time in replacing the bands on a burned-out armature

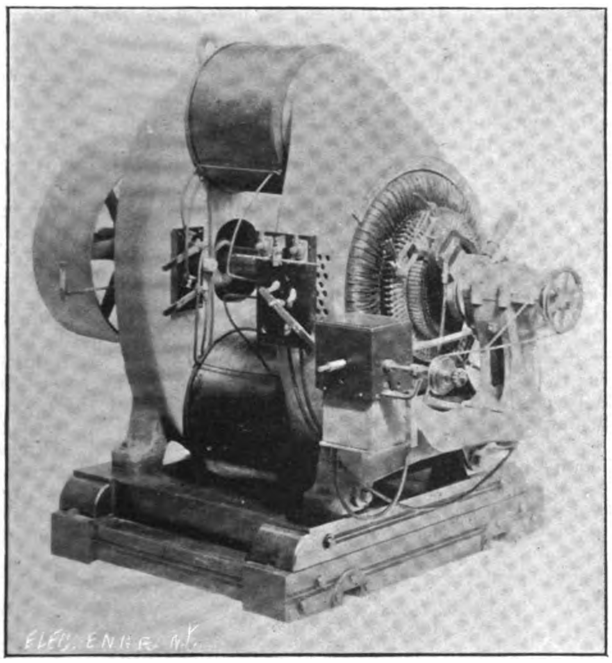


FIG. 1.—THE WESTERN ELECTRIC IRON CLAD ARC DYNAMO.

as he has in rewinding a burnt coil, will appreciate an armature in which the knocking out of a wedge gives complete access to a coil.

The general form of construction of these machines is shown in Fig. 1. The frames are of the bi-polar, horseshoe type, with the magnets horizontal . The magnet cores are of wrought iron and the pole pieces and yoke are of cast iron.

The pole pieces are divided in the center, thereby greatly reducing the cross magnetizing action of the armature. The pole pieces are so shaped that when the regulator is set to give an absolutely constant current at any load the field will be of the right strength to give the predetermined slight amount of sparking in whatever position the brushes may be set.

The bearings are of the self-oiling, self-aligning type, and are provided with visual oil gauge and drain. The pulley and end bearing is bolted directly to the yoke of the dynamo and the commutator end bearing rests on a brass bracket projecting from the lower pole piece. The bearing bracket is bored out at the same time the pole pieces are bored, so that the removal of the armature is a very simple matter. The bolt can be taken out and the bearing turned around the shaft until the foot is clear of its seat and the armature will then rest in the pole pieces and the bearing can be slid off with a very slight exertion.

The simple fact that the armature may be so easily and quickly removed for examination or repairs is a point that will be fully appreciated by all central station managers. The bearing may be removed in about five minutes, the pulley in three, and the commutator in ten. It may be re-

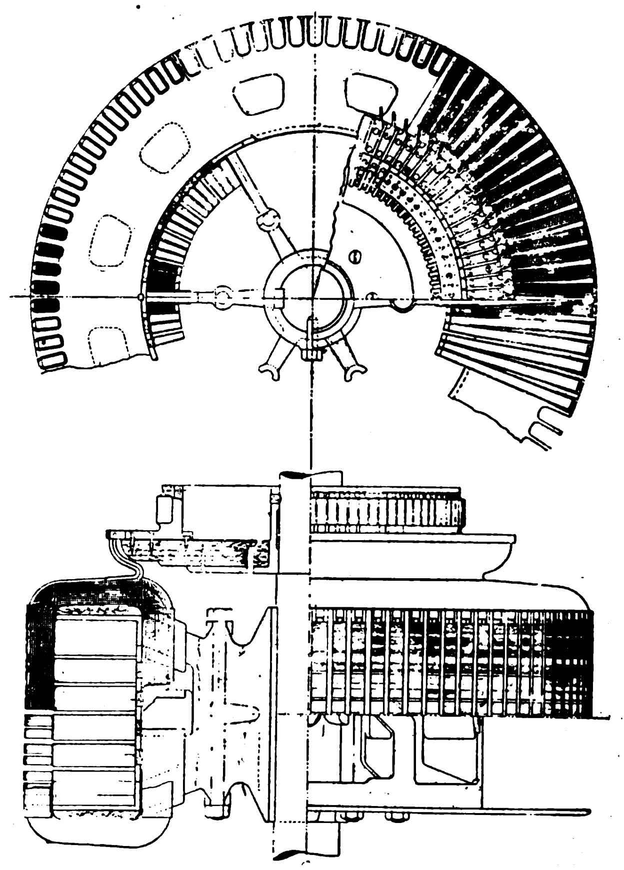


FIG. 2.

marked here that the time occupied by one man and helper in winding an armature coil is, on the average, 50 minutes for an 80-light machine, which is about an average size. The bearing seat affords a very convenient place in which to rest the armature, thereby doing away with the necessity of removing the armature completely from the frame.

The most vital part in all dynamos of high potential, is the armature. If the armature is not thoroughly insulated and designed for comparatively cool running, the machine is destined to a short life. The care taken in procuring first-class insulation of the armature is shown in Figs. 2 and 3. As will be seen, the armature is built up of very thin sheet iron rings mounted on a brass spider. The sheet iron rings have teeth similar to those in the standard incandescent ironclad armature; the coils are wound in the slots between the teeth and are firmly held in place by wooden wedges which are driven in over the top of the winding. The armatures are divided into a very large number of coils of comparatively few turns of wire. In this way the voltage in the individual coils is reduced to such a small amount that there is very little strain on

the insulation between coils and the voltage between segments of the commutator is so low that it is difficult to flash the machines under ordinary running conditions, and if flashing does occur the effect on the commutator is scarcely noticeable. By dividing the winding into a large number of small ventilated coils the accumulation of heat in the center of the coils is avoided, thereby preventing the slow roasting of the insulation which occurs in some machines.

The coils are insulated from the core in the slots by a trough which is built up of alternate layers of press board, mica and

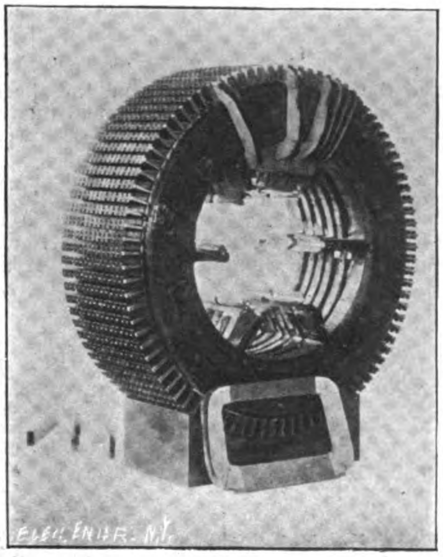


Fig. 3.—Armature Core Ready for Winding.

oiled paper, the sheets of mica being well lapped to avoid any chance of puncturing at the joints. The coils on the inside of the armature are wound in insulating troughs somewhat similar to the troughs in the slots, with the exception that they are narrower and deeper. The ends of the coils are insulated from the core; first, by wooden rings, which are placed at the ends of the armature and form rounded corners to wind over, as well as affording additional insulation; second, by built-up U-shaped troughs which overlap and extend in and around the inside and outside troughs. The result is, that each coil is wound in a separate trough built up of four overlapping troughs which effectually insulate it from each of the other coils and from the core. A complete trough is shown separate from the armature in Fig. 3.

The advantage of this form of construction is at once evident in case repairs become necessary, as any coil can be rewound without affecting the others in any way, and as there are no bands, all that has to be done is to slip the armature far enough out of the pole pieces to work on it and then take off the commutator and rewind a coil and put the armature and commutator in place again.

The 100 and 125-light armatures have a large space between the inside of the armature and the spider. On the 80-light and smaller machines the construction of the brass spider is such that the shaft and the greater part of the hub and spider can be taken out from the inside of the armature, so that there is a great amount of space on the inside of the armature and the facility for winding is very greatly increased. The inside and outside parts of the armature spider are drawn into perfect alignment again by six bolts with taper collars, as shown in Fig. 2.

In case one or even four or five coils of an armature become injured it is not necessary to rewind them at once, for if a coil is not short-circuited internally the terminals of the coil can be simply disconnected from the clamp on the commutator and a small jumper put across the same segments to which the coil was previously connected, and the machine can be run with no serious increase of sparking.

If any of the injured coils are short-circuited internally, of course the short circuit must be gotten out, or the whole coil may be cut out with a cold chisel. If this is done, it is necessary to take out the opposite coil also in order to keep the armature in running balance. A wooden wedge inserted in the place of the inner portion of the coil will serve to hold the other coils in place.

The following table shows the result of a test made on an 80-light machine, in which armature coils were cut out at various points:

No. coils cut out.	Volts.	Amperes without use of reduc. swchs.	Length spark.	Location of coils.
2	4,300	10.4	¼ in.	Adjacent
3	4,250	11.4	½ "	Adjacent
4	4,200	12	¾ "	Bunches of 4.
8	4,000	11.4	¼ "	Adjacent
12	3,800	12.2	⅝ "	Bunches of 2.
16	3,600	10.4	¼ "	Bunches of 3.R
16	3,600	13.2	¾ "	4 bunches of 2 and 8 single coils distributed around the Armature.

The spark is somewhat increased in length, but is not of a nature to damage the commutator.

The current may be reduced from that shown in the table to the normal amount, by the use of the reducing switches, without materially affecting the length of spark, as will be seen from the following test: A five-hour run was made, with sixteen coils cut out in four bunches of two and the other eight unequally distributed about the armature. The current was ten amperes and gave a quarter-inch spark. At the end of the run there was no sign of undue heating and the commutator was not injured in the least.

The all important factor producing long life in an armature, after good insulation has been secured, is that of ventilation. The success of the system of ventilation adopted is shown by a test in which two armatures were built just alike except that one was wound in the usual way, and in the other the coils were ventilated, as shown in the engravings. The former heated 80 degrees F. above the air after a 12-hour run, while the latter only heated 60 degrees F., after a 24-hour run.

The armature discs are supported by extensions on the spider. These points of support which are about two inches wide are directly over the spider arms, as shown in Fig. 2. Between the spider arms, in the open spaces, are laid small wooden blocks about one-quarter of an inch thick, which separate the armature coils from the discs and between every three or four coils on the inside of the armature are ventilating spaces. These ventilating spaces which are shown very plainly in Fig. 2 open into ventilating chambers in the brass ring which carries the armature discs and this space communicates directly with the spaces between the iron discs, which are, of course, open at the outside where the iron teeth come between the coils. By this means there is a free circulation of cool, fresh air in through the coils, coming in at the bottom and flowing up through the ventilating spaces between the armature discs and out between the armature teeth. In addition to this the brass spider arms are partially cut away where they pass through the winding at the bottom so that there is an additional opening for the admission of fresh air into the spaces between the armature rings. The iron armature rings are held apart in bunches of about sixty by radial strips of asbestos, which, from their action as a centrifugal blower, tend to keep the fresh air flowing through the armature.

The special feature of this system of ventilation and insulation is that the entire ventilating space in the armature may be filled up with carbon or copper dust, leaving the insulation of the machine as strong to resist the breaking down strain, due to the voltage, as it was before, for the reason that each

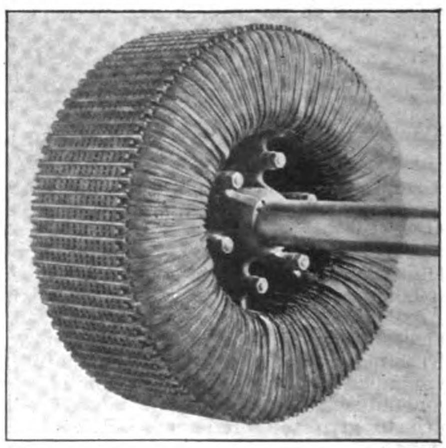


Fig. 4.—Armature Complete, Pulley End.

coil is insulated independently of the rest in a trough which completely protects it.

The mechanical superiority of the ironclad armature over the surface wound is most apparent when necessity requires it to be handled, either in placing it in the dynamo or moving it about the station. It may be rolled about the floor without injurious results, as it is absolutely puncture-proof.

The field coils are wound on paper spools 1/8 to 3-16 inch thick, which are built up and flanged over outside of the 1/2-inch wood veneering heads. The spools are held away from the iron core and the yoke and pole pieces by wooden wedges so that there is a large ventilating space all around the inside and at the ends of the spools. The construction of the spools is such that should this ventilating space become filled with dirt the coils are still effectually insulated.

On the yoke of the machine shown in Fig. 1 is mounted a pair of reducing switches which cut out part of the field winding. The lower switch is for the purpose of adjusting the spark at the brushes to the conditions under which the dynamo is running. When this switch is open the machine will run along without flashing under normal conditions, though the spark is in this way reduced practically to nothing. If there are sudden and great changes of load, it is desirable to have the machine run with a slightly longer spark so that it will not flash before the regulator has a chance to compensate for the change in the load; this can be accomplished by simply closing the switch.

The other reducing switch is for the purpose of reducing the current output of the dynamo so that if it is desired to run the machine part of the time at a lower current than 9.6 amperes this switch can be closed and the regulator adjusted to the lower current. In this way considerable fuel can be saved when it is not necessary to run the lights at full brilliancy.

The commutator, which is shown in detail in Fig. 2 and complete in Fig. 6, is built up on a very substantial disc of hardwood veneering which is mounted on a brass flange. This wooden disc is then faced with mica and each segment is screwed to it independently of the others. The segments are tapered slightly towards the inside, allowing slate wedges to be driven in between them, thereby protecting the mica facing from the action of any burning that might be caused by the flashing of the dynamos. The outside ends of the segments are held rigidly by a compound ring of mica and veneering and each segment is held in position on this ring by a machine screw and two dowel pins. The segments are insulated from each other by air spaces allowing both sides of each segment to be perfectly inspected and cleaned at any time when the machine is not running.

With an air insulated commutator the burning effect of flashing and short circuits is confined almost entirely to the brushes so that it is not necessary to turn down the commutator after bad flashing, as is the case with solid built commutators. The carbon brushes feed down and compensate for the burning as soon as it is over. All parts of the commutator which are connected with the circuit of the machine, are on the face of the wooden disc so that there are no parts behind the commutator which have to be cleaned to keep the insulation from

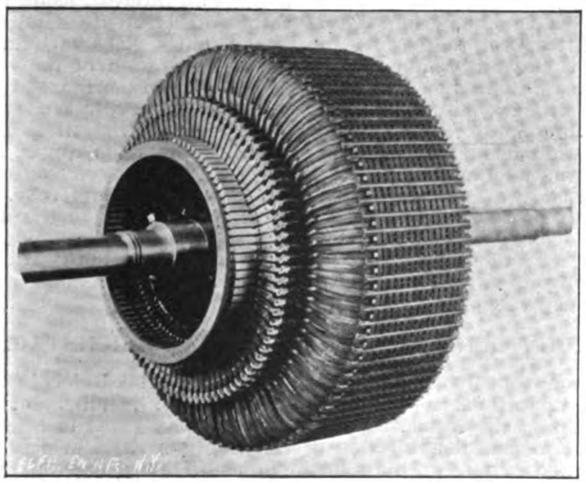


FIG. 5.—ARMATURE COMPLETE, COMMUTATOR END.

running down. Also all screws used in its construction are accessible from the front. The segments are increased in size at the working part so as to provide for a long life and also to hold the flashing as much as possible in the working part of the segments. This form of construction has the additional advantage that it is not dependent on slate or rubber or any other brittle material for its mechanical support and yet the mechanically substantial insulation is thoroughly protected by the slate wedges from the burning action of flashing.

The brushes are arranged to cover the commutator over the entire angle spanned by them, and whatever sparking occurs, is concentrated at the tip of the brush. At the brush tip is provided a small independent brush which is automatically fed down to compensate for the increased wear due to the spark-

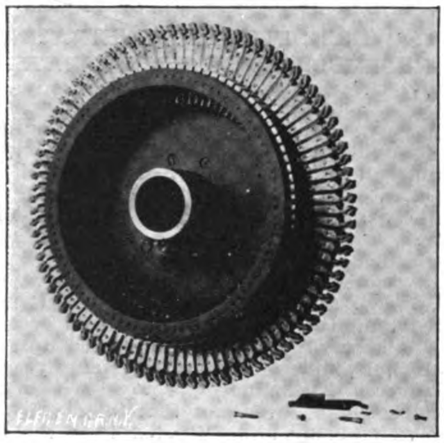


FIG. 6.—COMMUTATOR COMPLETE.

ing at this point. This independent brush is so narrow that the brush angle remains practically constant, no matter how fast the brush may be worn away by sparking. The tension of all brushes, there being four to each holder, is adjusted by vulcanite handles, carrying a worm screw, which slip down over ratchets; by turning the rubber handle carrying the worm screw the brush tension can be adjusted accurately, and when it is desired to replace a brush the handle and brush spring can be removed entirely from the brush holder and the carbon taken out and inspected or renewed.

In some of the older forms of carbon brush holders used on air insulated commutators, considerable annoyance was experienced from the noise caused by the chattering of the brushes. This has been almost entirely obviated by the construction adopted. In these brush holders the main brushes cover several segments at once and all the brushes are urged by springs in the direction in which the commutator rotates, so there is no chance for the brushes to vibrate. With these brushes it is not necessary to oil the commutator.

The connection board has a substantial slate base on which is the line switch and lightning arrester. The lightning arrester is shown at the top of the board in Fig. 1 and consists of two carbon pencils, one connected to each side of the line, which are held horizontally and in close proximity with a grounded carbon plate midway between them. As soon as the lightning jumps across, the arc is almost instantly blown out by the field from the pole piece of the dynamo. The arresters have been found to work very satisfactorily in long continued and severe storms.

The operation of the machines is fully equal to that of the old surface wound type. The lamps can be thrown off or on in groups equal to 10 per cent. of the capacity of the machine from full load down to short circuit or vice versa and the regulator will compensate for the changes without flashing the machine. Or the whole load may be thrown on or off instantly and the regulator will compensate for the change in a few seconds.

The machines withstand without injury the ordinary accidents of operation, such as open circuit and short circuit and either side of the circuit may be grounded to the frame and the circuit opened without injuring the insulation.

A test was recently made to ascertain the rise in potential at the terminals of an 80-light machine. A load of ninety lamps on a very short line was put on the machine and the line opened as nearly instantaneously as possible at the switchboard. The potential was taken at the terminals of the machine with a Weston voltmeter. With the machine running at 4,500 volts, the voltmeter swung up to 5,500 volts, when the circuit was opened; at a load of 3,300 volts, the needle swung to 4,400. This shows that there is no marked difference between the ironclad and surface wound machines in this respect. If the circuit had been opened in the middle of a long

line the rise in voltage and consequent strain on the insulation would have been so small as to be hardly worth figuring on.

The machines are all designed to run fourteen hours on any load from dead short circuit to full-rated capacity without heating in any part more than 70 degrees Fahrenheit above the surrounding air.

The Western Electric Company manufacture this type of dynamo for 50, 60, 80, 100 and 125-light capacity, and are also prepared to furnish these sizes for direct connection to the standard high speed engines.

LIGHT RAYS WHICH, IN THEIR PENETRATING POWER, RESEMBLE ROENTGEN'S X-RAYS.

BY N. D. C. HODGES.

The purpose of this note is to call attention to the properties in common of certain radiations which, while somewhat unusual in character, have been classed hitherto as light rays not essentially peculiar in their method of propagation, with those radiations which are now known as Röntgen's X-rays.

Fox Talbot, about 1840, first observed spectra in which the order of the colors was not as usual (red, orange, yellow, green, blue, indigo and violet), but in which the violet was less refracted than the red and other colors of great wave-lengths. This observation was not followed up at the time; in fact, it was not published for nearly twenty years. In 1860 Le Roux discovered that iodine vapor possessed not only a very remarkable absorbing power, but that the spectrum was abnormal, the violet being less refracted than the red. From that time till the present, anomalous dispersion has been frequently investigated by physicists and chemists; but the difficulties have been great, and comparable quantitative results have been few, as witness the labors of Le Roux, Christiansen, Kundt, Soret, Mach and Osnobischin, Wernicke, and others. However, the existence of the phenomenon is no longer denied, as it was by some soon after the announcement of its discovery; and fortunately it is possible very easily to get qualitative results, i. e., to break up a beam of white light into two parts, of which one, consisting of the rays ordinarily most refrangible, is less refracted by some substances than is the other, consisting of the rays of greater wave-lengths. In fact, De Klerker (Comptes Rendus, 1879) maintained that the anomalously dispersed rays were not refracted at all by the substance producing the dispersion. At any rate we have light rays not as subject to refraction as are ordinary rays, and in so far they approach Röntgen's X-rays in character. The question is, Have these two classes of radiations other properties in common?

To test the power of penetration which the anomalously dispersed rays might possess for substances usually opaque to light rays, I used a so-called "pocket kodak," carrying a strip of film sufficient for twelve exposures. This camera was placed in the closely-fitting pasteboard box in which it is sold, the shutter opened, the cover (lined with carbon paper) being immediately shut down. In this way sections 1, 3, 5 and 7 were exposed to pure sunlight (in so far as it could penetrate the pasteboard end of the box) for 5, 10, 15, and 30 minutes respectively. For sections 2, 4, 6, 9 (8 was accidentally allowed to pass unused) the exposure was not to pure sunlight, but upon the end of the box upon which the light fell was placed a prism formed of two microscope slides held together at an angle of only a few degrees, and in which a small quantity of a dilute alcoholic solution of fuchsine was held by capillarity. On development the film showed an increasing amount of fogging as the length of time the different sections had been exposed increased. But as section 8, which had not been exposed, showed a marked amount of fogging, it was evident that light had entered the camera in some way so as to reach the sections of the film which it had been assumed would be protected.

To avoid any overlapping effect and separate as completely as possible the parts of the film acted on by the pure sunlight from those acted upon by the anomalous rays, in the second experiment sections 1, 2, 3, 4 were, in succession, exposed to pure sunlight (so far as it could penetrate the end of the pasteboard box, as above) for 5, 10, 15, and 30 minutes, respectively; sections 5, 6, 7 were passed by without exposure, so as to furnish plenty of film to wrap about the first four sections and to separate the pure sunlight action from that which came later; sections 8, 9, 10, 11 were exposed for 5, 10, 15, and 30 minutes, respectively, to the anomalous rays, as before, the fuchsine prism being attached to the end of the box. On developing, the first four sections were found to be unfogged; a slight fogging appeared on section 6, and from there on the fogging increased with the length of exposure. Again, sections which would be amply protected from ordinary light showed a fogging which could have been produced only by rays which must have passed through the wooden sides of the camera and the paper of the box.

In order to increase any tendency to luminescence inside the camera, a strip of white blotting paper was inserted in the dark chamber of the camera and kept there through all the exposures. It will be understood that the pure sunlight had to pass through the side of the pasteboard box, and that it produced no fogging in the control exposures (which have since been repeated, but without the blotting paper), while the anomalous rays to produce the fogging must have passed through not only the pasteboard but also through the wooden sides of the dark chamber of the camera, and probably through the leather and wood covering of the camera.

It would appear, therefore, that the violet rays which result from anomalous dispersion of sunlight by refraction through a prism of fuchsine have a power of penetration for paper, leather, wood and black cloth—substances which are opaque to the whole light of the sun.

PROF. WOODWARD'S ALUMINUM VACUUM TUBE FOR GENERATING X-RAYS.

Prof. F. L. Woodward, of the Lawrence Scientific School at Harvard, has devised a new form of vacuum tube, by means of which excellent cathodographs have been obtained. As the sides of the lamp permit cathode rays to pass through them, the fact that with it cathodographs may be obtained contradicts the theory that a glass envelope plays an essential part in the generation of Röntgen rays.

This new form of vacuum tube is that of a cone, and its characteristic difference from the ordinary Crookes tube is that the walls of the lamp are of sheet aluminum, one-tenth of an inch in thickness. The base of the lamp is of solid glass, practically a plug fitted into the base of the aluminum cone with plaster of paris and made air tight. A metallic ring passes around the base of the cone and holds the sides of the cone firmly to the glass bottom. Through a point a little to the side of the center of the glass base passes the cathode terminal into the lamp, and at the end of this is fastened a platinum disc at such an angle as to be parallel with the side of the lamp. At the top of the lamp and directly connected to the metallic side is the anode terminal, and at the top of the cone is a glass tube with a stop cock, so that the air may be exhausted. This glass tube is also fastened in with plaster of paris, and bound by a metallic ring. A circular wooden disc is fastened inside the metallic cone, to prevent any collapse of the sides on exhaustion. By this construction it has been found that the difficulty from the absorptive power of the rays by the glass of the Crookes tube has been eliminated in a most marked degree.

As yet, Mr. Woodward has worked with this lamp with induced currents of between 25,000 and 30,000 volts, and with such power very clearly defined radiographs of the hand have been taken in five seconds. It seems from this that, with a higher current, say 50,000 volts, an instantaneous photograph may be taken and the heavier parts of the body readily photographed.

The new form of a vacuum tube has an interest, aside from its construction, from the fact that experiments conducted with it appear to disprove the theory that a glass vacuum envelope plays a significant part in the generation of the Röntgen rays. This theory was advanced by Röntgen himself, and was strongly supported by Poincaré. But Prof. Woodward has obtained excellent cathodographs from the radiations passing through the sides of the aluminum cone of his lamp. This supports another theory, to the effect that Röntgen and cathode rays are independently generated in a vacuum tube, but that the former alone have the power of traversing the glass envelope. The fact that clearly defined cathodographs of the hand were obtained in five seconds shows that Röntgen vibrations are greatly weakened in passing through the glass of the ordinary vacuum tube.

ROENTGEN RAYS IN THE GERMAN REICHSTAG.

Baron von Buol-Berenberg, president of the Reichstag, issued invitations recently to the Ministers, members of the Reichstag, the Bundesrath, and the German press to be present at a special exhibition of the Röntgen rays, which was given by Professor Spiess in the Session Hall of the Reichstag on Thursday, Jan. 30. The great hall was crowded and most of the Ministers were present. Professor Spiess, after making a number of experiments, delivered an explanatory address in which he suggested that science would soon be so developed that they would be able to photograph the contents of secret documents through the letter boxes. The only means of safety the Ministers had, he said, was to use letter boxes made of lead.

THE ELECTRICAL EQUIPMENT OF HAMMERSTEIN'S "OLYMPIA."

THE electric lighting of a large theater differs so essentially from that of ordinary buildings as to afford a vast opportunity for the ingenious arrangement of electrical devices and effects, and requires careful study in its design. Not only must the illumination be very great for the size of the building, but this illumination must be so arranged as to produce the proper aesthetic and scenic effects, and must be under instant and complete control, so that any or all the lights in the building may be dimmed or raised or thrown off or on at the will of the stage attendant, and above all things must be absolutely reliable. Crowds of people fill the building nightly, and if through the failure of some part of the apparatus the hall should be left in darkness a serious panic might arise. Only the best apparatus, therefore, should be used for theater lighting, and its installation must be carefully studied and thoroughly accomplished.

The lighting plant of Oscar Hammerstein's new "Olympia" affords a striking example of this class of electric engineering. The whole work was planned by and carried out under the supervision of Mr. John Thompson, Mr. Hammerstein's electrical engineer, and great credit is due him for the complete success of the plant.

The boiler room is located under the side walk at the north side of the building. It contains a battery of two boilers of the Campbell-Zell type, each of 500 horse power capacity at 80 pounds steam pressure. The grates are arranged for burning pea-coal, which travels on an incline from the bunkers without any labor of handling. An electrical tell-tale water level is being designed for the boiler room and will soon be in service.

Before reaching the engines, the steam passes through a Stratton separator, which effectually removes all moisture from it. The entire building is heated by exhaust steam from the engines, by direct and indirect radiation. The steam after leaving the engines passes through a Hine & Robertson grease extractor, where it is freed from its oil. It then passes to a Webster heater, and thence to the heating system, from which the water of condensation is returned and pumped into the boilers. All steam pipes are thoroughly covered, and of such a size and so well laid out that the whole heating system involves a back pressure of less than one pound per square inch.

There are two engines of the Corliss type, made by the Hewes & Phillips Iron Works. They have cylinders twenty inches in diameter, a 42-inch stroke and operate at a speed of 90 revolutions per minute. Each engine carries a 16-foot flywheel with a 38-inch double crowned face, driving by two belts a pair of generators. The belts are three ply, made by the Page Belting Company.

The four generators thus driven are of the ironclad multipolar type, manufactured by the Eddy Electric Manufacturing Company of Windsor, Conn. Each has a rated capacity of 100 kilowatts at 125 volts and 600 revolutions per minute, and in addition each machine will easily carry an overload of 25 per cent. for several hours. The frequent and sudden fluctuations in the load of the generators, due to the throwing on and off of a large number of lights, are very similar to the severe changes in load of street railway service. This point was considered by the manufacturers, and the machines were constructed to meet the same conditions as their street railway power generators. So free are the generators from any trouble from sparking that it is possible to throw the entire load off and on at the main switch without an indication of the machine that it is loaded or not, except in the tightening and slacking of the belt, and without any change in the "lead" of the brushes.

The sad accident that occurred at this building on the morning after its opening will be remembered by all. The steam pipe that caused so much sorrow and damage deluged the generators with a flood of steam and boiling water, and yet so thorough and perfect was the insulation that within a few hours, and in this soaked condition, each generator was operating at full load. This was certainly a most severe test of the reliability of the apparatus.

The generators are connected to the switchboard so that either one singly, or any number in parallel, may furnish current for the lighting system. Each generator is controlled by a three-pole main switch, located at the bottom of the marble switchboard. The switchboard also carries the field rheostats (which are arranged behind the board, the handle alone showing on the front), four 1,000 ampere ammeters, voltmeter and seven circuit switches; the last control feeders leading as follows: Theater front, music hall stage, music hall front, electric sign and lobby.

The electrical plant was installed by Messrs. H. B. Coho & Co., who deserve great credit for their arrangement and management of the matter.

The distribution of the electric power over the building is of great interest, alike from an engineering and from an aesthetic point of view. The conductors are everywhere carried in armored conduit. The control of light from the stage radically differs from that usually employed. An ingenious relay switch patented by Mr. John Thompson, the chief engineer, is the basis of the whole arrangement. The theater and music hall are both controlled by a bank of buttons, mounted on a single marble slab, 16 x 28 inches. The switches themselves are located in convenient parts of the building, and connected with the buttons. Aside from the cumbersome nature of the regular switchboard, which is thus avoided, the wiring to the relay switchboard involves a mere fraction of the copper that would otherwise be necessary. Further than this the construction of the switches is such that it is very easy to gang them; that is, to have all or any number operate by the pressure of a single button. This switchboard is very unassuming in appearance. The lights are controlled in brilliancy by rheostats. Each circuit has a handle swinging on a pivot, by means of which its light can be dimmed down to a faint glow. In addition, a handle swings a long bar carrying sectors, to which any or all of the rheostats' levers can be attached by a quarter turn of the handles, and thereby operate simultaneously. The great number of combinations that can be made to work in unison is at once apparent. For instance, assuming that the theater lamps are burning at full brilliancy, it is desirable to dim the side lights and the lights in the body of the theater, leaving the footlights and the lights in the flies burning, but not at full brilliancy. Locking all of the levers into the gang switch, the latter would be drawn forward until the footlights and the lights in the flies were dim enough. By a quarter turn of the handle controlling them they would then be left behind, and the dimming of the rest of the lights could be continued at pleasure. In like manner an almost indefinite number of combinations can be made, which will work harmoniously and with pleasing effect. The main lever has an adjustable extension which can instantly be brought into play to give a greater leverage. Two projector arc lamps light each stage. These lamps are very ingenious, the design of Mr. Thompson. The carbons are at right angles and the light of the positive crater is thrown directly forward without any reflector or lenses, though, of course, the use of these devices greatly increases the projecting power.

HAMMERSTEIN'S OLYMPIA, NEW YORK.

The decorations both in music hall and in the theater itself are strikingly beautiful. The chandeliers are hung with glass pendants, prisms and multifaced bulbs, and are probably the largest electric glass chandeliers in the country. The arms, and, in fact, all but the joints, are of glass, and are wired entirely from the inside. Both houses are lavishly decorated with papier mache work, painting and statuary, from the smallest cherub to the eight-foot heroic figure. The theater is finished in blue, while the opera house is in red. Besides the theater and opera house there is a concert hall, which is also elegantly appointed. Glass chandeliers and fitting decorations are everywhere and every arrangement is made for the comfort of patrons. Lundell fans set in holes just under the pitch of the roof keep the hall well ventilated.

The total number of lamps is 4,500 incandescent and 28 arcs. In addition, the stage projectors, the signs and the lights for the scenic effects constitute a variable portion of the equipment. On one scene alone in the opera "Marguerite" 984 lights were used for decorative purposes. These arrangements are largely designed and executed by Mr. Thompson, who has a very

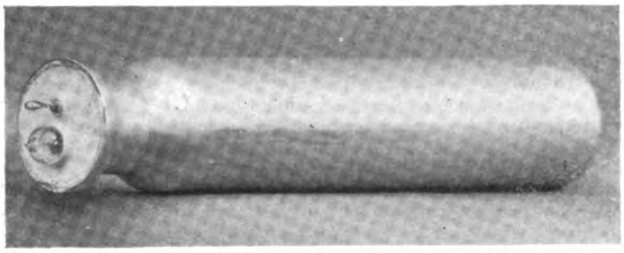
enviable record as a theater engineer. He was in charge of the first lighting plant in any theater—that of Booth at Baltimore. in 1877. Since then he has been continually employed at noted theaters at similar work, thus obtaining an experience which is very difficult to duplicate.

AN ALUMINUM VACUUM TUBE FOR X-RAY EXPERIMENTS.

BY WILLARD E. CASE.

In a former article, the author has shown that photographs could be taken of objects through solid plates by placing them between two condenser plates, or by making the object to be photographed, the anode; the cathode rays passing by it and casting the shadow of the anode upon the plate.

Heretofore sensitized covered photographic plates could be acted upon through solid bodies, with the use of the Crookes tube (which was made of glass and transparent, and through



THE CASE ALUMINUM VACUUM TUBE.

which the glow could be seen). The writer has constructed the tube here illustrated, which was made entirely of aluminum. being about 6 inches in length and 1 inch in diameter. The tube at one end is solid. Through the other end of the tube was inserted the cathode terminal and a very small miniature incandescent lamp bulb, which is used for the purpose of seeing whether or not there was a glow inside the tube when operated. The tube was then exhausted to the point of purple glow; perhaps not sufficiently high. The tube was connected up with an induction coil and the tube itself was made the anode.

For the first experiment, this tube was energized, was placed over an ordinary plate-holder, containing a sensitized plate and operated for some time in an absolutely dark room. No light could be seen from the outside of the tube, although some persons present insisted that they could locate the tube in the dark room. The sensitized plate was acted upon.

The shape of the tube and arrangement of the electrodes is not that which further experiment will probably determine to be the best, as it would appear that the rays were thrown in every direction in this particular form of tube. This is stated for the benefit of those who may wish to experiment further along these lines.

A MODEL RESIDENCE SWITCHBOARD.

BY WILLIAM C. HUBBARD.

In the plant recently installed in the residence of Mr. E. J. Berwind, New York, the idea that whatever beauty may exist in electrical installation should be concentrated at the switchboard, is carried out without sacrificing any desirable features; on the contrary many ideas leading to greater compactness and facility of operation have been embodied in the design.

The board, as shown in Fig. 1, is constructed of white Italian marble, with all the automatics enclosed in brass-bound separable bevel glass cases, set on marble shelves, giving the whole a handsome appearance.

The following services are controlled by means of this board: The street service, the current generated by a Siemens & Halske dynamo, driven by an Ideal engine, the storage battery charge and discharge currents; the water supply for both elevator and house use, the ventilating and heat regulating apparatus, the charging and ...scharging currents of the small storage cells used for operating the call bells, burglar and fire alarms and telephones. All the switches, measuring instruments and automatics being located on this board, the advantages of centralized control are obtained and the plant can be operated by one man, with the minimum of labor.

The house is wired with 3-wire mains and two-wire branches for outlets and lights, about 81 miles of tubing and wire having been used. The mains are brought down to the switchboard and connected to the three-wire busses on the back, Fig. 2, it having been found advisable under certain conditions of load distribution in order to secure more perfect equality of light, to operate on either the two-wire or three-wire systems, connecting the dynamo and batteries in multiple or series, as conditions might necessitate. These connections as well as the necessary crossing of the two outer bus bars are made by means of the double-throw switch shown at the lower right hand side of the board.

The charging or discharging of the batteries is accomplished by means of the double-throw switch, shown at the lower left side of board which also cuts in the proper automatics. The double-throw pivot switch in the lower center of the board

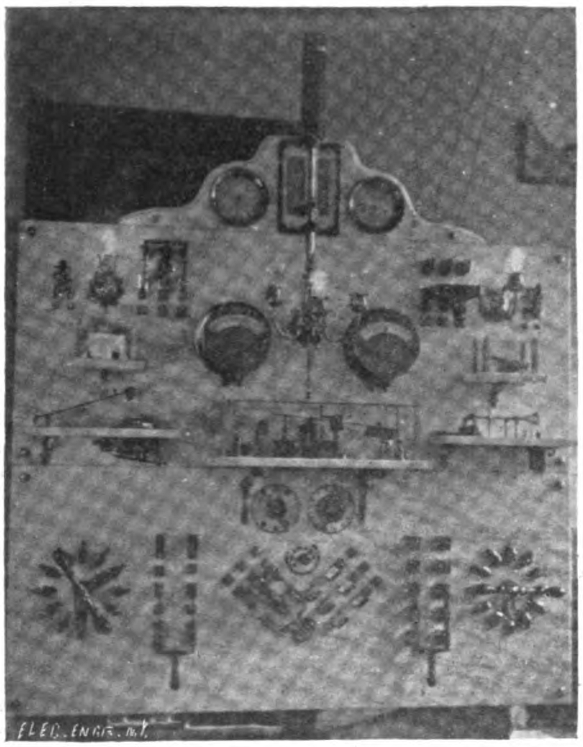


FIG. 1.—SWITCHBOARD, BERWIND RESIDENCE, NEW YORK.

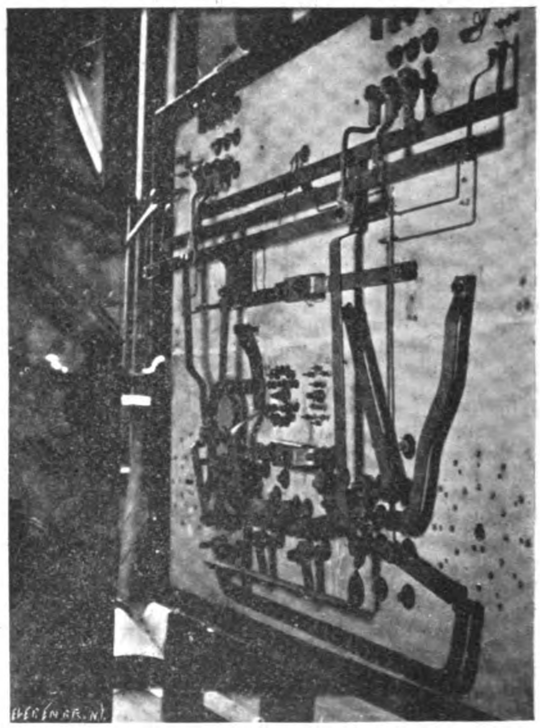


FIG. 2.—REAR VIEW OF SWITCHBOARD.

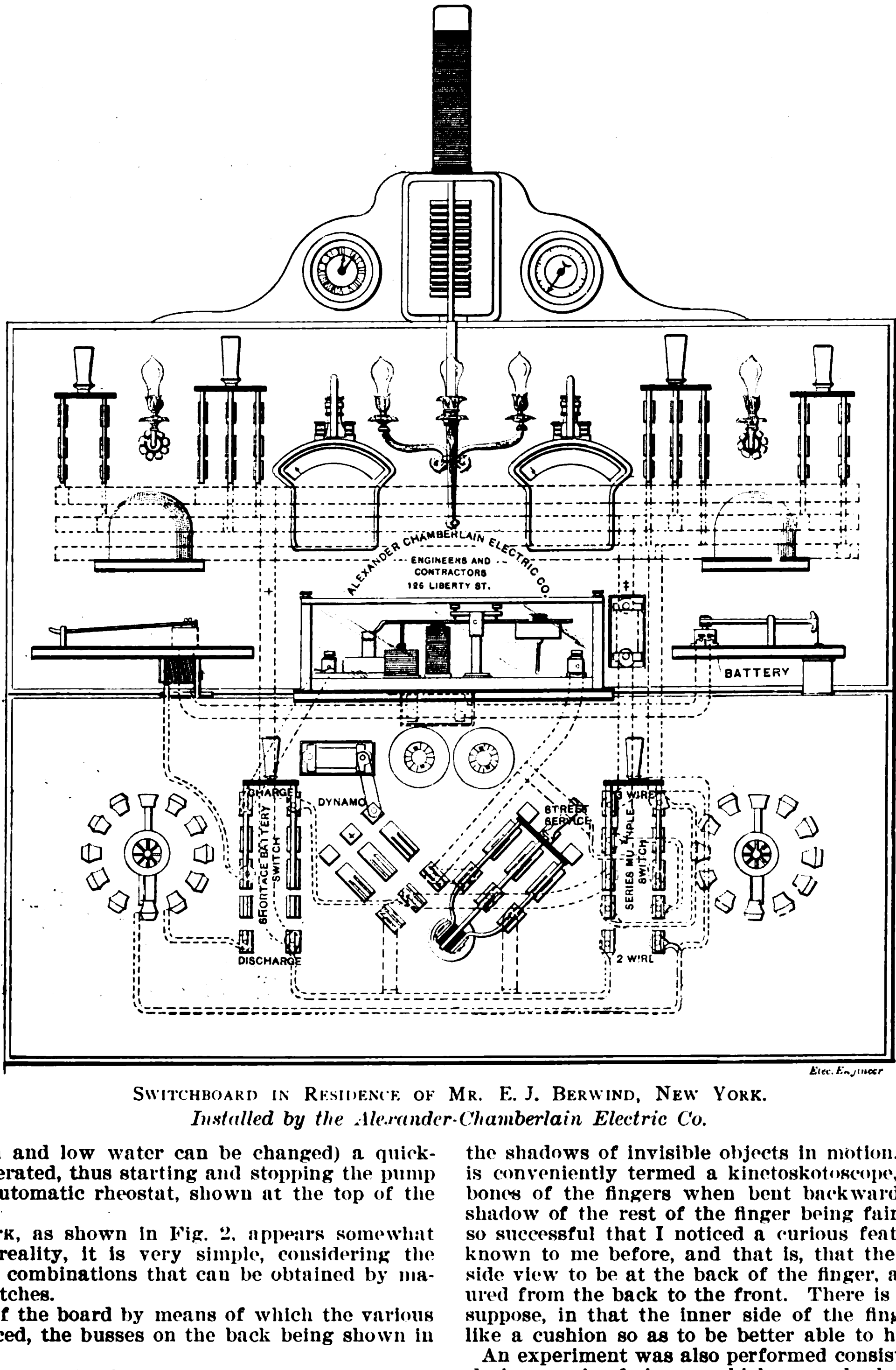
connects the house wiring with either the street service or the current from the plant.

In order to take current readings from different points a switch was designed and constructed which would connect the ammeter (a Weston detached shunt instrument) with any one shunt, and such are the construction and connections of this switch that there is practically no error in the readings. Readings of the E. M. F. are taken by means of a Weston voltmeter connected to the various points by the usual means.

All the water used in the house is supplied by an electric pump which forces the water into two tanks located in the attic, the water level in each being controlled by a cylindrical float having a rod rising from it and sliding in guides. By means of two adjustable collars (by shifting which the difference between high and low water can be changed) a quick-break switch is operated, thus starting and stopping the pump by means of the automatic rheostat, shown at the top of the board.

The bus bar work, as shown in Fig. 2, appears somewhat intricate, but, in reality, it is very simple, considering the many changes and combinations that can be obtained by manipulating the switches.

Fig. 3 is a plan of the board by means of which the various circuits can be traced, the busses on the back being shown in broken lines.



SWITCHBOARD IN RESIDENCE OF MR. E. J. BERWIND, NEW YORK.
Installed by the Alexander-Chamberlain Electric Co.

ELECTRIC LAMPS FOR TICKET COLLECTORS.

The ticket-collecting staff at Vauxhall have just had served out to them small electric lamps, which are fixed on their overcoats, the current being supplied from a miniature battery carried in the breast pocket. The experiment is to be tried for a month, and if it finds favor with the officials, electricity will supersede the old-fashioned and somewhat cumbersome hand-lamp. This arrangement has long been in use among the ticket inspectors on South London tramcars.—Westminster Gazette.

APPLICATION OF X-RAYS FOR MAKING VISIBLE OBJECTS IN MOTION.

BY EDWARD P. THOMPSON. M. E.

MR. M'KAY, of the Packer Institute of Brooklyn, has tested my idea mentioned in "The Electrical Engineer" of Feb. 19, as to the possibilities of exposing upon a fluorescent screen the shadows of invisible objects in motion. We saw in what is conveniently termed a kinetoskotoscope, the motion of the bones of the fingers when bent backward and forward, the shadow of the rest of the finger being faint. The result was so successful that I noticed a curious feature which was not known to me before, and that is, that the bones appear in a side view to be at the back of the finger, and very thin measured from the back to the front. There is a reason for this, I suppose, in that the inner side of the finger should be more like a cushion so as to be better able to handle objects.

An experiment was also performed consisting in opening and closing a pair of pincers which were absolutely invisible to the eye, but the shadow of the moving parts was clearly visible upon the screen. A chain was shaken back and forth, and the separate links moving relatively to each other were clearly visible. These experiments would prove that with the present condition of the X-rays the skeleton of a fish could be seen

to move backward and forward in the act of swimming, as well as the skeleton of all small objects while in motion, and performing the functions of life. I think that some of the best objects to be looked at while in motion would be, for instance, a bird, through which the rays would so easily pass except as to the skeleton. All youthful forms of life could be examined, very probably, by this means, and the motions exhibited.

My first experiment was an attempt to show that if a bone were broken in a living person's limb the fracture could be made visible by bending or stretching the limb. I began by taking a bamboo tube. Small iron rods were introduced from opposite ends until they met. These rods were invisible to the eye by ordinary light. When they were separated more or less, the gap between the rods within the tube became instantly visible on the fluorescent screen, and the rods could be seen to move away from each other through the opaque bamboo tube, while the latter appeared as if it were made of glass.

Another experiment produced the apparent effect of a solid passing through a solid. A large needle was driven through a block of wood, and the point of the needle could be seen to enter the wood. A somewhat similar experiment was performed with the hand. The needle was not driven through the flesh, but on the side of the hand opposite the eye, and the needle was clearly visible, and the moving point could be followed to different parts of the hand. This suggests a possibility in surgical operations, where it would be desirable to follow the point of the instrument through the flesh in vivisection. Another object seen was a fountain pen entering its opaque rubber cover.

I have for two or three weeks been trying different kinds of experiments, and I find that certain precautions are necessary in order to obtain the best results. In the first place, it is necessary, very probably, to show just how I made my fluorescent screen, because I find that others have tried to make it by crystallizing the chemical barium platino cyanide from a solution upon a sheet of paper. Others merely pressed the crystals upon a surface like filter paper. Such screens are of little value, especially as the substance then fluoresces blue which is nearly invisible, and only so in spots. By the following means, the results are so excellent and the screen is so luminous that the shadows are clearer than in the X-ray photographs. The cyanide should be powdered to the finest dust possible. Then some of the clearest colorless varnish should be put upon a piece of tracing cloth because the same is so strong, and so transparent to the fluorescent light which is produced. The powder may now be mixed very thoroughly and intimately with the varnish, so as to make a homogeneous mass, in quantity sufficient to spread over the cloth to a thickness of about one-eighth of an inch. This is mentioned because experimenters are likely to make the layer too thin. The reason for powdering the material is to produce a maximum amount of reflecting surface. The object of the varnish is to hold it together, and yet to permit the reflected rays of fluorescent light to become visible. The varnish should then be dried, but not necessarily perfectly dried. These directions should be followed very closely for good results.

The end of the tube which is directed towards the Crookes tube, and which contains the screen should be covered with photographers' black paper used for wrapping sensitive plates. Either side of the screen may be directed towards the Crookes tube. A very important precaution is to perform the experiments in a rather dark room. It may be light enough to be able to see objects, but if the room is very light, the eyes are not used to darkness, and therefore the experiments are not satisfactory, but if the room is quite dark, the screen in the closed tube appears immediately upon putting the eye to the hole in the tube, to be perfectly luminous. It will be more luminous under these precautions than luminous paint which has been held in the sunlight, and brought into a dark room, and yet if performed where the eyes are exposed to daylight the experiments are not so satisfactory. Another precaution is to have the electrical apparatus so arranged that the phosphorescent light from the Crookes tube is steady, which may be done, of course, by means of Leyden jars or other condensers. My idea of this new use of X-rays was conceived and attested Feb. 1, 1896.

SEEING WITHOUT LIGHT.—A CORRECTION.

In describing the device of Mr. E. P. Thompson, of seeing without light in our issue of Feb. 19, an error crept in. In the fourth paragraph, first column of page 191, instead of "The tube should contain a fluorescent light" read: "The tube should contain a lens."

PRESIDENT P. H. FLYNN, of the Nassau Electric Railroad Company, of Brooklyn, will, it is stated, resign during the next six months.

THE SOURCE OF THE X-RAYS.

BY

Elihu Thomson

To trace the rays to their actual source within the Crookes tube, there was placed within a pasteboard box, such as dry plates are packed in, two plates, one at the bottom, facing down, and another at the top, facing up. They were kept apart by wads of paper. One thickness of pasteboard covered each of them. This box was laid flat on the table and on its upper side was a small iron object of distinct outline, above which was suspended the Crookes tube. About 600 spark discharges through the tube (time, 8 minutes) effected an impression. The image on the top plate was found to be slightly larger than the object, while on the bottom plate, which was ⅞ of an inch below the first, a much larger image was impressed, showing a divergence of rays from some point above the object. Here, it may be remarked, the lower picture was produced through two thicknesses of glass, namely, that of the plates, which were relatively back to back.

On constructing a simple geometrical figure in the form of a triangle, using the longest dimension of the object image on the lower plate, for the base, and making the sides pass through the ends of a line ⅞ inch (distance of plates) from the base line and of a length equal to the longest dimension of the image on the upper plate; the apex of the triangle, is of course, the ray source. This was found to coincide with the cathode terminal of the Crookes tube, and, although, from the position of the terminal, the rays must have passed in large measure very obliquely through the glass, they were not in any way deflected from their straight course.

ON RADIANT MATTER.—III.

BY WILLIAM CROOKES, F.R.S.

RADIANT MATTER WHEN INTERCEPTED BY SOLID MATTER CASTS A SHADOW.—Radiant matter comes from the pole in straight lines, and does not merely permeate all parts of the tube and fill it with light, as would be the case were the exhaustion less good. Where there is nothing in the way the rays strike the screen and produce phosphorescence, and where solid matter intervenes they are obstructed by it, and a shadow is thrown on the screen. In this pear-shaped bulb (Fig. 9) the negative pole (a) is at the pointed end. In the middle is a cross (b) cut out of sheet-aluminium, so that the rays from the negative pole projected along the tube will be partly intercepted by the aluminium cross, and will project an image of it on the hemispherical end of the tube which is phosphorescent. I turn on the coil, and you will see the black

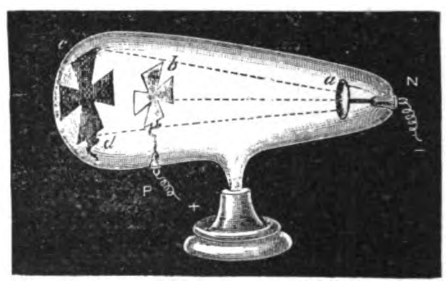


FIG. 9.

shadow of the cross on the luminous end of the bulb (c, d). Now, the radiant matter from the negative pole has been passing by the side of the aluminium cross to produce the shadow; the glass has been hammered and bombarded till it is appreciably warm, and at the same time another effect has been produced on the glass—its sensibility has been deadened. The glass has got tired, if I may use the expression, by the enforced phosphorescence. A change has been produced by this molecular bombardment which will prevent the glass from responding easily to additional excitement; but the part that the shadow has fallen on is not tired—it has not been phosphorescing at all and is perfectly fresh, therefore, if I throw down this cross—I can easily do so by giving the apparatus a slight jerk, for it has been most ingeniously constructed with a hinge by Mr. Gimingham—and so allow the rays from the negative pole to fall uninterruptedly on the end of the bulb, you will suddenly see the black cross (c, d, Fig. 10) change to a luminous one (e, f), because the background is now only capable of faintly phosphorescing, while the part which had

the black shadow on it retains its full phosphorescent power. The stenciled image of the luminous cross unfortunately soon dies out. After a period of rest the glass partly recovers its power of phosphorescing, but it is never so good as it was at first.

Here, therefore, is another important property of radiant

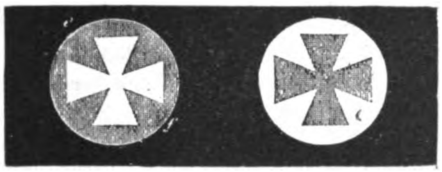


FIG. 10.

matter. It is projected with great velocity from the negative pole, and not only strikes the glass in such a way as to cause it to vibrate and become temporarily luminous while the discharge is going on, but the molecules hammer away with sufficient energy to produce a permanent impression upon the glass.

RADIANT MATTER EXERTS STRONG MECHANICAL ACTION WHERE IT STRIKES.—We have seen from the sharpness of the molecular shadows, that radiant matter is arrested by solid matter placed in its path. If this solid body is easily moved, the impact of the molecules will reveal its strong mechanical action. Fig. 11 repre-

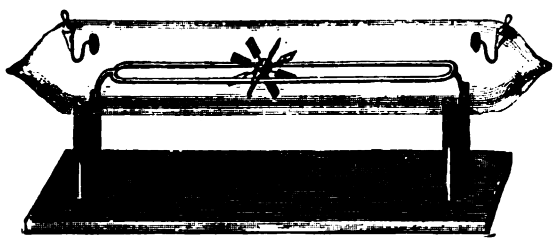


FIG. 11.

sents an ingenious piece of apparatus, constructed by Mr. Gimingham, which, when placed in the electric lantern, rendered this mechanical action very plainly visible. It consists of a highly-exhausted glass tube, having a little glass railway running along it from one end to the other. The axle of a small wheel revolves on the rails, the spokes of the wheel carrying wide mica paddles. At each end of the tube, and rather above the center, is an aluminum pole, so that, whichever pole is made negative, the stream of the radiant matter darts from it along the tube, and, striking the upper vanes of the little paddle-wheel, causes it to turn round and travel along the railway. By reversing the poles the wheel can be arrested and sent the reverse way; and if the tube be gently inclined, the force of impact is observed to be sufficient even to drive the wheel uphill.

This experiment therefore shows that the molecular stream from the negative pole is able to move any light object in front of it.

LETTERS TO THE EDITOR.

FUSE SHUNTS ON MAGNETIC CIRCUIT BREAKERS.

In the Feb. 26th issue of "The Electrical Engineer" is a letter from Mr. James H. Bates concerning automatic magnetic circuit breakers. Mr. Bates recommends the use of automatic magnetic circuit breakers on motor cars and urges the use of carbon final breaks to prevent arcing of the main switch jaws of circuit breakers.

While we agree with him that a carbon break is an excellent means for preventing blistering of the main contact jaws, still we cannot leave his letter go by without drawing attention to the advantage of the use of the fuse shunt protection to the jaws of the magnetic circuit breaker. There are several very important advantages in the use of the fuse shunt. First, the means of keeping tally on the motorman the number of times he opens his circuit breaker. Too much stress cannot be placed upon this feature, as one of the chief reasons railroad companies are adopting circuit breakers for their cars is to cut down the power station consumption, and if a record is not kept of those motormen who are continually opening the circuit breakers, the advantage sought for is thwarted.

Second. The use of fuse shunt protection permits the manufacture of a less complicated form of construction than would be by using carbon final break.

Third. In event of circuit breaker opening under conditions where the current rises just to the current flow necessary to move armature, thus tripping the catch, throwing main switch out, the fuse will not open immediately upon such switch movement. This enables a car to be brought to a standstill in event of an emergency reversal of a single motor equipment. Of course, in event of a "dead short circuit" or a heavy "ground" the "blowing" of the fuse is practically simultaneous with the opening of the main switch.

Fourth. It goes without question if "blistering" and "burning" of contacts can be entirely overcome, the types of circuit-breaker embodying such a feature, would be better adapted for the equipments of street railway work than one which would blister if certain parts were not kept in certain adjustment.

I am glad that Mr. Bates has taken the stand he has, as there is no question but a great saving can be effected by the use of automatic magnetic circuit-breakers on cars.

W. E. HARRINGTON.

Philadelphia, Feb. 27, 1896.

X-RAYS NOT IDENTICAL WITH CATHODE RAYS.

Why is it that nearly all your contributors insist on confounding the cathode rays, which have been known since the experiments of Crookes, with the new rays discovered by Röntgen, and which, for the want of an appropriate name, he has temporarily named "X-rays"? He has himself plainly shown in his presentation of the subject, and expressly states that the X-rays "are not identical with the cathode rays, but are produced from the cathode rays at the glass surface of the tube."

I must confess the confusion referred to led me considerably astray until I read the translation of Röntgen's paper in your issue of February 12. In order to be more specific, the X-rays are not deflected by a magnet (according to Professor Röntgen), nor do they proceed perpendicularly from the cathode plate, nor do they resemble cathode rays or any other kind that we know of except in their rectilinear propagation and chemical action on sensitive plates.

Another confusion which I note particularly in Mr. Robertson's paper of your current issue, ought not to pass without notice. This is a tendency to assimilate the new rays with magnetic lines of force. Those who do this have apparently forgotten that the lines of force are not the direction of propagation of energy or anything else. They are merely the direction of the attraction, and as such are static, so to speak, while anything in the nature of rays or waves is dynamic, nor can I see that there is any means by which one can be transformed into the other.

Perhaps with the confusions above mentioned the unscientific word "cathodograph," with the prima facie more ridiculous, but not more abortive, "raygraph," will disappear and give way to a better.

GEORGE W. COLLES, JR.

Boston, Mass., Feb. 26, 1896.

FACT AND FANCY IN CATHODOGRAPHY.

I wish to correct some of the worst errors made in the daily papers, which, however, perhaps have already been attributed to the reporters and printers by those who have had any experience in interviews. I did not perform any experiments at the Edison laboratory. It was at the Edison Lamp Factory. I there tested some tubes which Mr. John W. Howell was kind enough to have manufactured for me. I did not say that I could see the heart beat. I know nothing about future developments and possibilities. I did not invent the idea of seeing a bird during actual flight and thereby be able to solve the problem of flying machines. This was invented by some reporters, who became exceedingly enthusiastic upon my imparting to them the knowledge of my acual propositions and results. The most and very successful experiments were performed by me, by the cordial consent of Prof. McKay, at the Packer Institute, Brooklyn, N. Y. Some early and preliminary experiments were also made for me by Prof. Pupin, of Columbia, College, New York.

E. P. THOMPSON.

New York, Feb. 28, 1896.

LUCID AND EXHAUSTIVE.

Mr. Wetzler's article on "The Edison Electric Illuminating Company of New York," in the Jan. 8 number of "The Electrical Engineer," is one of the most lucid and exhaustive articles of the kind which it has ever been my pleasure to read. It should be studied by every one interested in central station work. Please accept my hearty congratulations.

EDWIN R. WEEKS.

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CONTENTS.

SUPPLEMENT.

THE BALTIMORE TUNNEL ELECTRIC LOCOMOTIVE.

THE action of a number of steam roads in equipping some of their branches with electricity may be considered a sufficient argument as to the recognized superiority of electrical propulsion over steam direct on short lines. But to what extent electricity is applicable to the operation of general trunk line service is still an open question, though it has been the subject of quite active discussion. The series of papers on this subject by Mr. William Baxter, Jr., which are now appearing in "The Electrical Engineer," are probably the most exhaustive which have yet been written on the subject. We will not forestall the conclusion arrived at by Mr. Baxter as the result of his analysis of the conditions as they exist at the present time, but it is perhaps to be regretted that he did not have at his disposal the results of the tests of the General Electric Locomotive in the Baltimore tunnel, which we print elsewhere. These tests, made by the aid of the well-known dynagraph car of the Pennsylvania Railroad, are the first authentic records of an electric locomotive comparable in power with such as would be required for trunk line service, and hence deserve more than passing notice. These tests show, as was to be expected, that the electric locomotive exceeds in smoothness of operation the steam locomotive, and that broken couplings and other trouble caused by the varying crank positions of the drivers would be practically eliminated on roads equipped electrically. As to tractive power and the ability to pick up a load from dead rest, enough was shown to place the electric locomotive at least abreast of the steam. Another important feature brought out by these tests was the efficiency of the electrical system, which is shown to be higher than with steam direct. Altogether the results obtained are eminently encouraging, and they will undoubtedly have an important effect on future work of this character.

ELECTRIC LIGHTING IN MASSACHUSETTS.

FEW documents reach us that are more valuable as bearing upon the commercial conditions of electric lighting in this country than the annual reports of the Board of Gas and Electric Light Commissioners of the Commonwealth of Massachusetts, and we are glad to receive the eleventh in the series, just issued. The insight obtained from such reports into the nature and scope of the business can only be understood by those who actually handle and study these documents for themselves; and, while we think there are definite limits to be set to the powers of such bodies, we cannot believe that work of the kind here brought to notice can be other than beneficial to the interests whose relations with the public and with the stockholders are governed.

It would appear from this report now before us that the electric lighting companies have suffered in common with other industries of like nature, dealing directly with the public. The year 1895 was even worse than 1894, and we hope that the bettering conditions of 1896 will set the companies squarely on their feet again. As it is, we find a total revenue of $3,822,-196, and a total profit from all sources of $1,227,809. Against this there were charges of $234,444 for interest, $487,148 for dividends, $565,287 for depreciation and $123,177 for sundries. These actually show a deficit in the balance sheet for the year of $182,248, whereas in 1894 the companies pulled through with a surplus, after everything was paid, of $51,275. It would seem proper to reduce the dividend rate on such a showing, yet none of the companies are extravagant in that direction. One company pays 8½ per cent., three or four pay 8 and thence they straggle down to 2 per cent. Out of a total of 62 companies 33, or more than half, paid no dividends at all. The

gas companies in the State averaged much better, and their rates of dividend ran up in several cases to 10 and 12 per cent. At the same time, it is worthy of note as proo. o. the rapid growth of electric lighting that while the gas companies of the State, so long established, for the most part, paid out $1,086,878 in dividends, the electric companies paid out not far short of half as much. Many of the gas companies are also, as is well known, electrical current producers.

A noteworthy feature of lighting in Massachusetts has been the tendency there towards municipal ownership, and evidence of this condition of affairs is seen in the statistics of this report. It appears that official reports relative to action about such plants for gas or electric lighting—chiefly the latter—were received from no fewer than 238 towns and cities of a population over 1,500 each. It is lucky that precipitate action is not possible, or the increase in public debt would certainly be alarming. Out of these municipalities only 24, or a bare 10 per cent., took any action; the other 212 remaining as they were for the present. The number of such plants in actual operation is still limited to a dozen, of a total 2,330 horse power, and they appear to be fairly well run, although it is difficult to see any particular cause for jubilation over their economies of public money.

One of the functions of the board is to protect existing companies from unfair new competition if they are doing their work well, and another is to prevent them from an undue issue of securities based on insufficient assets. Both duties seem to be carefully and honestly discharged. Such work is of a delicate and difficult nature, yet when well performed it must go far towards enhancing the stability of the investments, and this is something that electric light companies can heartily apreciate and welcome.

THE ELECTRICAL EXPOSITION.

ALTHOUGH it is two months before the meeting of the National Electric Light Association and the holding of the Electrical Exposition in connection therewith in this city, there are already many indications that both will be a great success and go far towards marking a distinct revival in all the old electrical industries, as well as the springing into existence of many new ones. The association is taking vigorous measures to make its convention memorable for good, useful work, and we are glad to learn that it has, even thus early, secured the promise of a large number of valuable contributions, some of which, indeed, are of the highest degree of importance. This fact will in itself secure a large attendance from all parts of the country of those specifically interested in electric light and power; but it has a further value as marking the early return that the association is securing from its progressive action and its laudable desire to stimulate the electrical arts at this juncture.

The exposition is certainly destined to enjoy great success. The proofs of the interest of New Yorkers in it are already numerous. Electricity touches modern life on so many sides that there really seems to be no end to the variety of the exhibits and the miscellaneity of the people to whom they appeal. It is evident now that in some lines the exposition will far surpass any previous attempt of the kind, and that these lines will be peculiarly those that appeal to the public imagination and purse. Desperate as general financial conditions have been, electrical industries would have known no hard times had the public been made as well acquainted as it ought to be with the endless ways in which electrical appliances can minister to its comfort and happiness. When people are enabled to see what they can do and how cheaply they can secure all the new inventions, a stimulus will be derived which will not only do enormous good to electrical trade in New York, but send revivifying influences throughout the country.

Illustrative of the remarks we have just made are the plans of the local Edison company, which is going in with the determination to show how thoroughly a modern central station as an inexhaustible reservoir of current can supply well nigh innumerable needs for light, heat, power, ventilation, sanitation, amusement, medical treatment, etc. We venture to say that the average city public has absolutely no idea of the conveniences that lie literally at its door, waiting to be recognized and used, and we shall be very much surprised if the local company does not derive a handsome direct return from its enterprise in the inquiries that it sets on foot from new customers of all kinds, and the orders that it books for current, for lights, motors and other apparatus. We presume other local companies will follow suit along these lines, which are educational and helpful in the best sense.

ROENTGEN RAY PROGRESS.

IT was to be expected that so radical a demonstration as that of Prof. Röntgen would be followed up closely, and that it would lead to other, if not as startling, at least more important results. Viewed from the standpoint of theory, evidence is rapidly accumulating to establish the fact that there is a class of rays having actinic power, which pass through most organic matter with ease and which are absorbed in varying degree by the metals and other inorganic bodies, but which thus far have been found to be not subject to the general laws controlling vibrational energy. Analogous, if not identical, rays, it would seem, are present not only in ordinary sunlight, but in the arc and incandescent light as well, so that many of the experiments performed with Crookes tubes can be made with the sources of illumination just mentioned, though the time required makes longer exposures necessary. Just to what extent these rays exist in sunlight is attested by the experiments made by Mr. N. D. C. Hodges, which are given elsewhere, in which it is shown that fuchsine has the power of anomalous dispersion, so that the violet rays have the power of penetrating substances usually opaque to light. No doubt, other substances will be found to have the same effect. Prof. Elihu Thomson has also continued his experiments in this direction, and details some interesting results obtained by him.

Viewed from the practical standpoint, the influence of the X-rays on fluorescent substances has already been taken advantage of in the practical construction of apparatus for observing the motion of the bones in the living body and similar not less startling performances. Mr. E. P. Thompson, who has been vigorously prosecuting these experiments, shows what precautions are necessary to obtain the best results. No doubt, we shall soon find apparatus of this nature among the indispensable requisites of every surgical operating room. As to the forms of vacuum tubes designed to generate the Röntgen rays to the best advantage, we note this week two types. One of these, constructed by Mr. W. E. Case, takes the form of a cylinder, while Prof. Woodward, of Harvard, has adopted a conical form.

As we go to press a cablegram from London announces that a Mr. J. G. Vine has been able to photograph at one end of a wire objects exposed between two vacuum tubes at the other end of the wire. The same experimenter declares that he will soon be able to photograph objects at any distance by means of the X-rays. This news seems almost too good to be true, but, after the confirmation of Prof. Röntgen's experiments in every detail, one feels reluctant to reject as entirely improbable even the most doubtful story involving the use of the Röntgen rays. If this announcement shall be based on fact, it would seem to pave the way to the long sought for "seeing by electricity." Perhaps a seeing attachment to the telephone set may be the next inducement offered to subscribers.

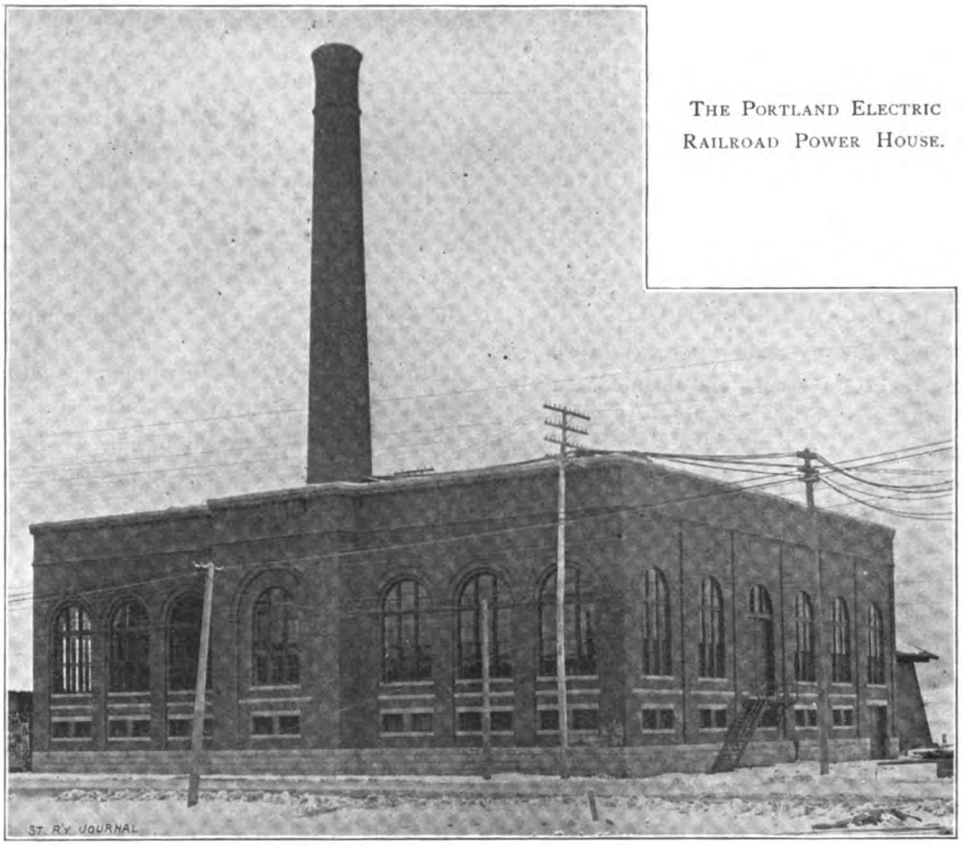
Electric Transportation.

THE PORTLAND, ME., ELECTRIC RAILROAD.

EARLY in the spring of 1895, the Portland Railroad Company, of Portland, Me., decided to change their motive power from horses to electricity, and in the beginning of April, ground was broken for the new power house, and the following month work began on track and line construction. The road, which is now completed, is in every respect a model, and railroad managers about to embark in a similar undertaking would find it to their interest and advantage to visit Portland and study the arrangements adopted.

POWER HOUSE.

The power house is located near Deering Bridge, on the water front, convenient to coal and water. Being built on reclaimed land, piles had to be driven, about 1,650 in all being employed for foundations. The piles were sawed off about one foot below mean high water line and concreted around with Portland cement concrete, one foot deep, flush, with the piles, then capped with granite blocks of such dimension that every capping stone rested firmly on at least three piles, and on top of this the foundation was built.


THE PORTLAND ELECTRIC RAILROAD POWER HOUSE.

The building itself is a substantial brick building with ornamental front. The inside dimensions of the engine room are 110x50 feet. The boiler room is 110x49 feet. Twelve feet of the boiler room is partitioned off by a wall and used for office, machine shop, oil room and storage room. The office and machine shop are on a level with the engine room floor and with entrance to the same from the engine room. Below the office is the oil room, which is built fire-proof throughout, and above the office is the storage room and lavatory.

Fronting on the street, in the engine room, a bay is built, 4 feet deep, in which the switchboard is located, flush with the inside line of the engine room wall. The feeders are brought from the switchboard inside of the bay, through the roof and from there over to the poles. No wires of any kind are visible inside of the building.

In the engine room there is also a traveling crane of 30 tons capacity, capable of handling the heaviest piece of machinery in the station. The traveling crane as well as iron trusses were furnished by Maguire & Jones, of Portland, Me.

CHIMNEY.

The chimney, which is located in the boiler room, is 16x16 feet square at the bottom and continues so about three feet above the roof of the building, where it commences as a round chimney, tapering to near the top, where it flares out in a neat design, giving it a very handsome appearance. The height of the machinery from the base is 145 feet. The inside diameter of the core is 6 feet 8 inches. The contractors for building and chimney were Messrs. Ridlon & Son, of Portland, Me.

ENGINE ROOM.

The present engine installation consists of three direct connected generators, room being provided for future extensions. Two of the generators are of 400 kilowatt and one of 200 kilowatt capacity. The 400 kilowatt generators run at a speed of 100 revolutions per minute; the 225 kilowatt at a speed of 120 revolutions per minute. The generators are the multi-polar ironclad type steel frame, built by the General Electric Company.

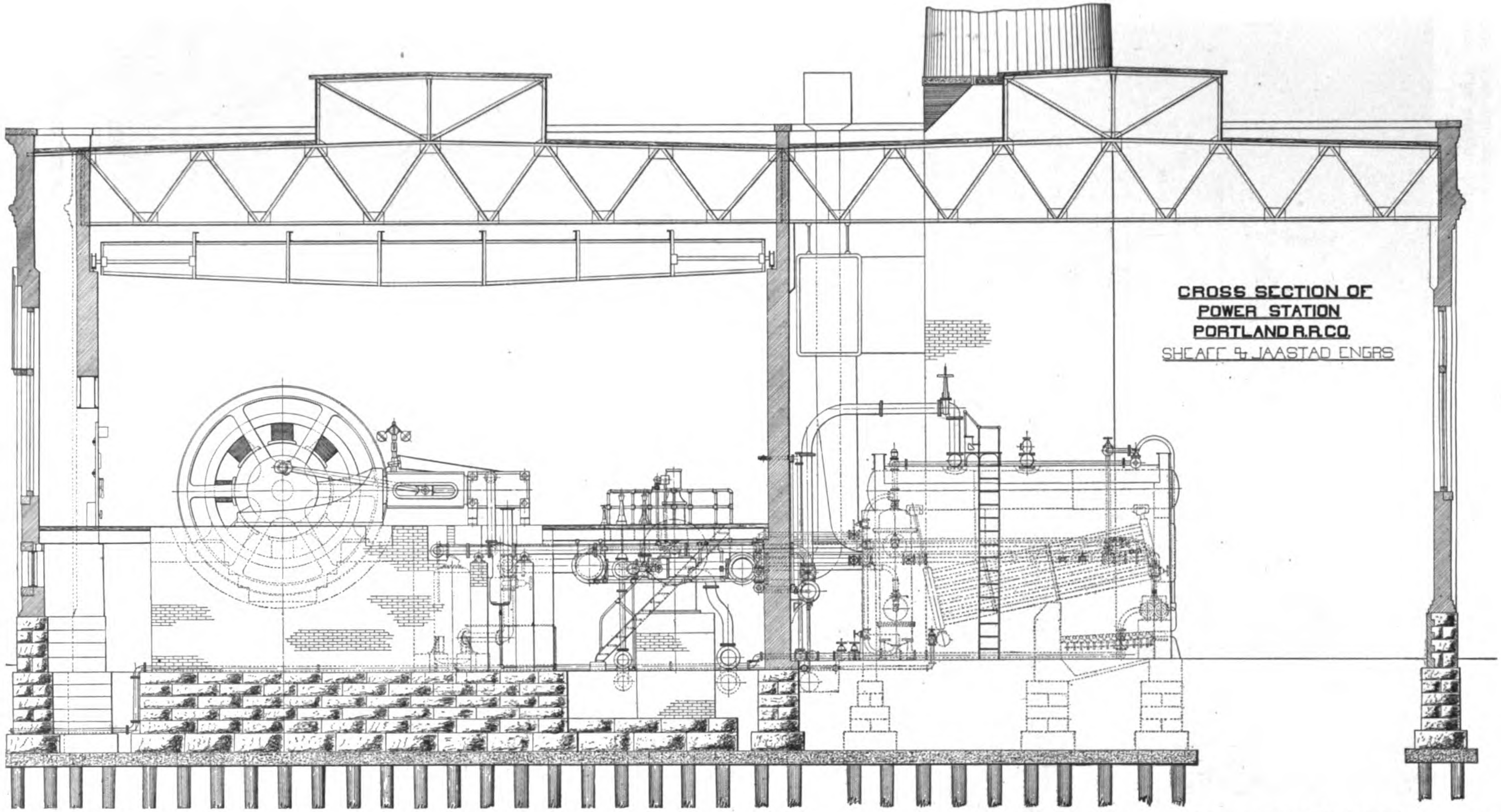
The engines are of the horizontal cross compound, condensing type, built by the E. P. Allis Company, of Milwaukee, with cylinders 14 inches by 26 inches by 36 inches for driving the 225 kilowatt and 18 inches by 34 inches by 42 inches for driving the 400 kilowatt generators These engines were built extra heavy throughout, so as to be able to withstand the excessive strain, due to the great variation of load that will necessarily arise on a road like this, where there are many very heavy grades. The engines are so arranged that either side, high or low, can be run independently, condensing or non-condensing if so desired.

There is one independent vertical flywheel condenser, of the E. P. Allis make, connected to each engine. These condensers are so arranged that their steam cylinders come up through the floor, making them easy of access, as shown in the sectional view on page 241.

BOILER ROOM.

In the boiler room there are at present two batteries of Babcock & Wilcox latest improved water tube boilers, each of a rated capacity of 500 horse-power. The boilers are all faced with white, glazed brick and present a very attractive and clean appearance.

In the boiler room there are two feed pumps 10 inches by 6



PORTLAND ELECTRIC RAILROAD POWER HOUSE.

SECTION OF ENGINE AND BOILER ROOM.

Sheaff & Jaastad, Consulting Engineers.

inches by 12 inches, built by the Blake Manufacturing Company, of Boston, Mass. Either pump is amply large to take care of the whole plant.

HEATERS.

There is one heater between each engine and condenser in the engine room, and one auxiliary heater in the boiler room, built by the Goubert Manufacturing Company, of New York.

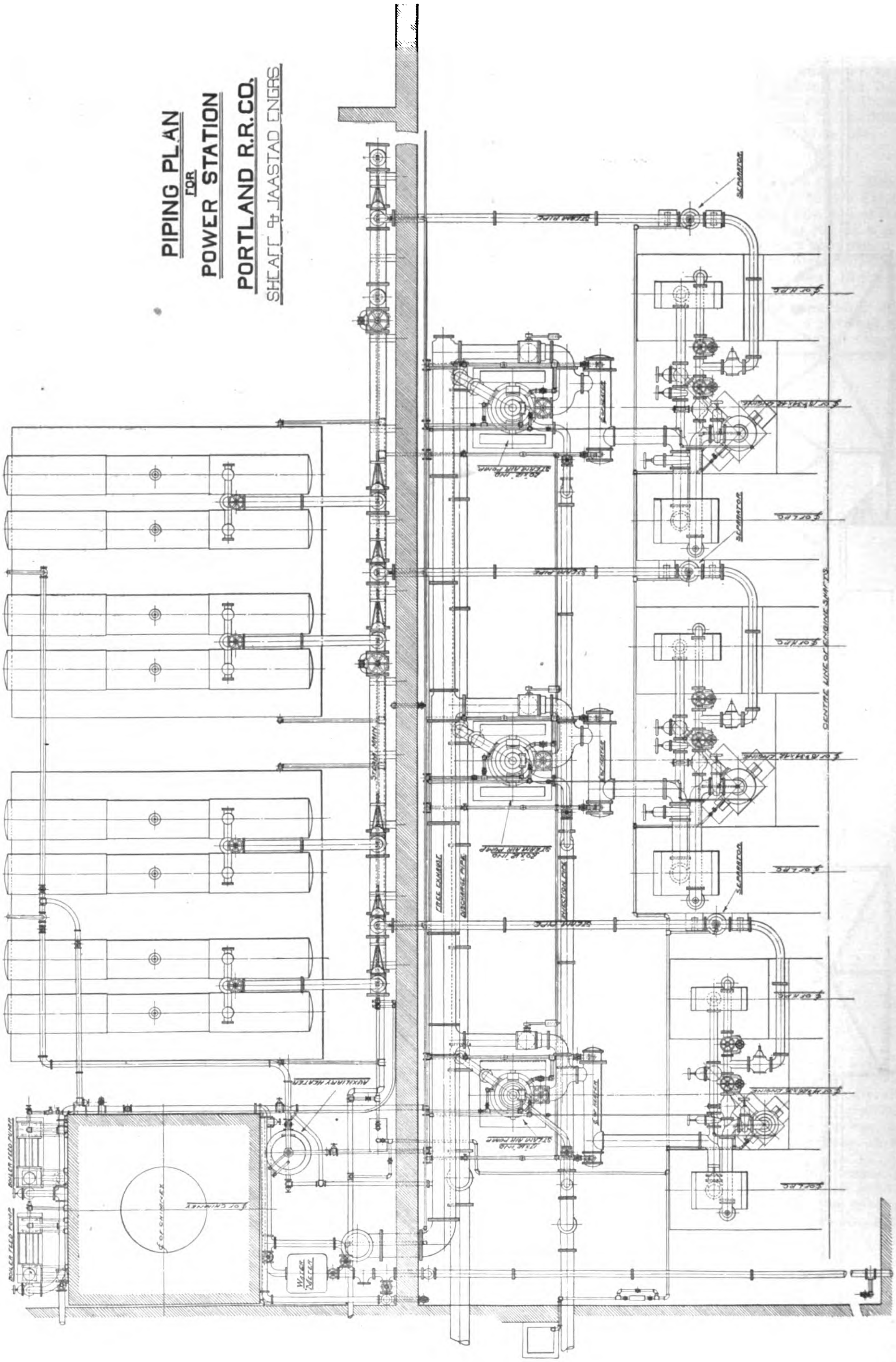
PIPING.

The steam main is carried on adjustable brackets bolted to the wall, back of the boilers in the boiler room, and in such proximity to the boiler room floor that the valves can be conveniently reached and operated from the floor by hand. The steam from the boilers enters this main through 8-inch pipes bolted to the nozzle of the boilers. This 8-inch pipe has a long bend so as to take care of the expansion and contraction.

The steam pipes to the engines from the main are carried through the partition wall, between engine and boiler room, as shown on the piping plan on page 242, under the engine floor to a Stratton separator, located near the throttle valve of each engine. As will be noted on the plan, these pipes are also provided with long easy bends so as to better take care of the expansion, and at the same time retard the speed of the steam as little as possible.

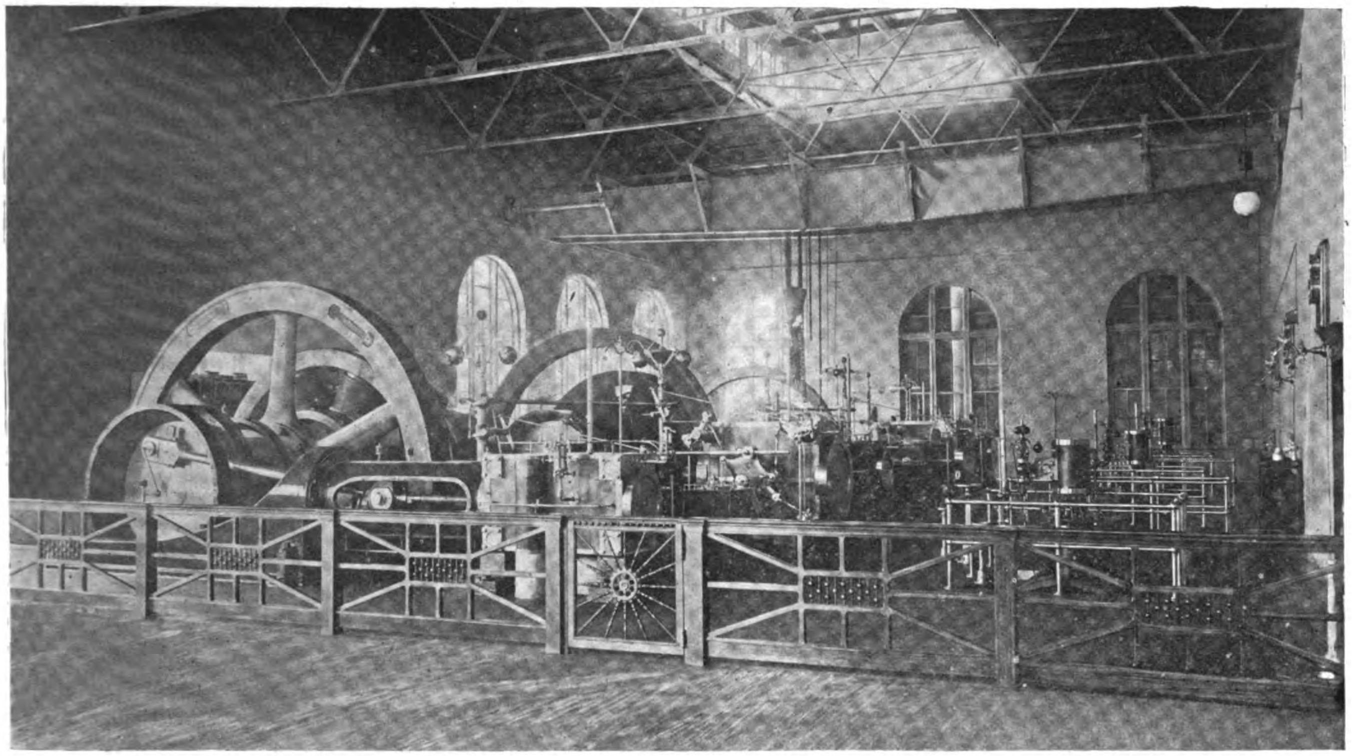
The exhaust steam, after leaving the engines, goes through a heater into the condenser, or it can go around the condenser out into the free atmosphere, as the case may be, dependent on whether the engine is running condensing or non-condensing.

The free atmosphere exhaust pipes from all the engines con-



THE PORTLAND ELECTRIC RAILROAD POWER STATION—PLAN OF STEAM PIPING.

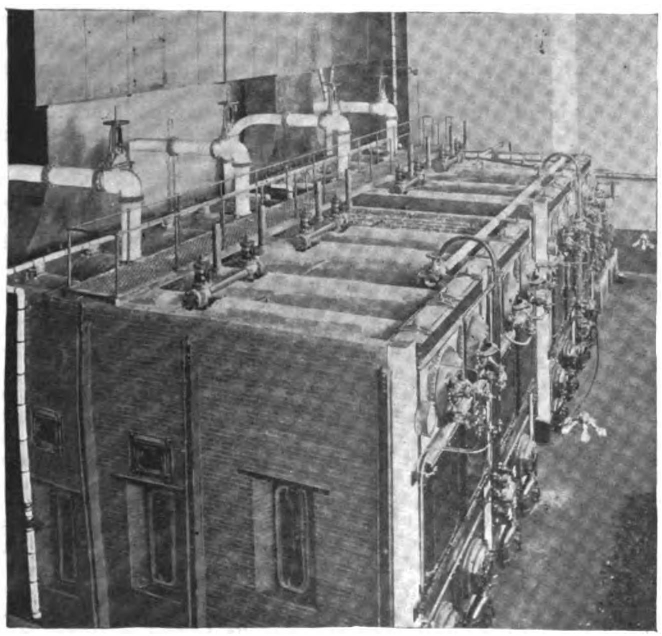
nect into one main exhaust pipe, which is carried to the boiler room, then up through the roof, ending in a Stein exhaust head. The suction pipe to the condensers is provided with a strainer placed in basement inside of building, by-passed, and so arranged that it can readily be gotten at and cleaned. The overflow pipe from the condensers discharge into the river.



The Portland Electric Railroad Power House.—View of Engine Room.

FEED WATER.

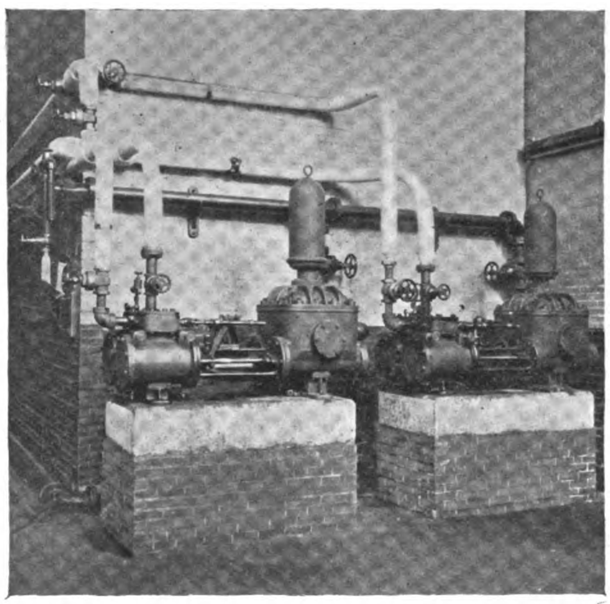
The feed water, which is city water, passes through a meter to the pumps in the boiler room, from where it is pumped first through the primary heater in the engine room, where it gets heated to from 125 to 130 degrees, then to the auxiliary heater in the boiler room, where the temperature rises to from 200 to 212 degrees, at which temperature it enters the boilers.



The Boiler Room.

The piping for this is so arranged that any or all of the promary heaters can be cut out and the water pass direct from the pumps through the auxiliary heater to the boilers, or the auxilary heater can be cut out, and it passes through the primary heaters direct to boilers, or all heaters, primary and auxiliary, can be cut out and the feed water can be pumped direct into boilers.

It is to be noted that the piping is so arranged that a complete break-down is impossible, as everything is in duplicate, with the exception of the steam main, which, however, by valves is divided into sections so that if anything should happen to one of the sections the remainder can be operated.



The Boiler Feed Pumps.

All drips from steam piping, separators and receivers are carried back to the boilers by the Holly return gravity system. It is also to be noted that all valves in the engine room base-

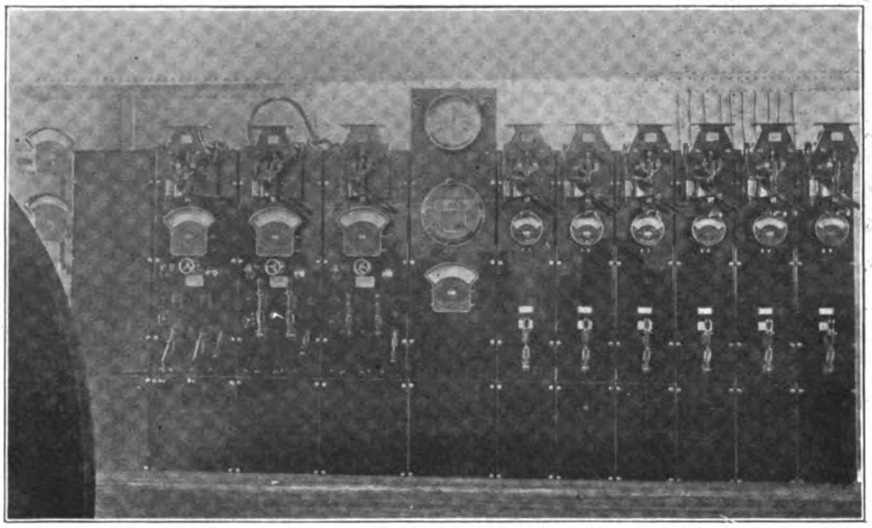
ment can be operated from engine room floor, they being provided with long stems and valve stands bolted on to the floor, shown in the view of the engine room on page 243.

TRACK CONSTRUCTION.

The tracks on the streets within the city limits are laid with 9-inch, 90-lb girder rails, on ties placed 2 feet 6 inches on centers. The track is thoroughly ballasted with clean, sharp gravel and paved with granite blocks. The rail connections are 38 inch, 12-bolt joint plates, double-bonded with No 0000 Chicago rail bonds. On the suburban lines 58-lb "T" rails are used, furnished by the Pennsylvania Steel Company. The special work was furnished by the Pennsylvania Steel Company and the Johnson Company. Messrs. Arthur Hodges & Co., of Boston, were the contractors for the track construction.

OVERHEAD WORK.

There are nine 500,000 circ. mils feeders leading out of the power house to the different lines, and in no place on the line is the maximum drop more than 10 per cent. The material used in the overhead construction was furnished by A. & J. M. Anderson, of Boston, Mass., and the contractors for the line work were M. K. Kendall & Co., of Boston, Mass.



THE SWITCHBOARD, PORTLAND ELECTRIC RAILROAD.

CARS.

The cars, open and closed, as well as snow-sweepers, plows, etc., were built by J. G. Brill & Co., of Philadelphia. The inside finish of the closed cars is in mahogany with plush covered seats. They are all artistically decorated and well lighted with incandescent lights, and heated by electric heaters.

The cars are equipped with the General Electric Company's "G. E. 800 motors and K.2 controllers.

That the railroad company is thoroughly alive to the ever-increasing demands on electric roads, as a means to outdoor enjoyment, is shown by the fact that they have purchased a large tract of land five miles out of Portland, converting it into parks and pleasure grounds. It is located on the Presumpscot River, and is one of the most delightful of the many picturesque spots in the State of Maine.

Great credit is due to the officers of the road and to their consulting engineers, Messrs. Sheaff & Jaastad, of Boston, who furnished all the plans and superintended the work of construction.

ELECTRIC SIGNALS ON THE PENNSYLVANIA R. R.

A new system of electrical signals for the starting of trains from Union Station at Pittsburg has been adopted by the Pennsylvania Railroad. It consists of long metal arms extending from the roof of the train shed to within a few feet of the top of the cars, one being directly over each track. On the end is affixed a lantern, covered on the side next the head of the train, with a red slide. When a train is ready to leave, the gateman will close the gate and push a button, which will cause the red slide to fall, showing a white light to the engineer. The latter cannot start his train until he "gets the block," and this places the starting of trains in the hands of the gateman. The system has been tried with success in the Broad Street Station, Philadelphia.

EXPERIENCE WITH THE ELECTRIC LOCOMOTIVE IN THE BALTIMORE TUNNEL.

AFTER a short period of experimental work, electric locomotive No. 1 on Aug. 4, 1895, took up the regular freight service through the Belt Line Tunnel of the Baltimore and Ohio Railroad in the City of Baltimore. The tunnel, which is the largest "soft dirt" tunnel ever built, extends from the present Camden passenger station of the Baltimore and Ohio Railroad, a distance of 7,350 feet north under the heart of the city.

Shortly after locomotive No. 1 had been put into service, and had given an exhibition of its ability to haul the heaviest freight trains, it became a matter of general interest as to how much it could pull and how fast it could go. The locomotive was therefore given a trial at hauling several of the passenger trains at high speeds, which it did satisfactorily to all concerned. As the conditions for operating the passenger trains entirely by the electric locomotive could not, on account of track facilities, be perfected until the new Mount Royal station, at the northern portal of the tunnel, was completed, it was decided to operate them in the meanwhile by coke burning steam locomotives. The new Mount Royal station will be ready in April or before, and preparations are now being made to then operate all trains, both freight and passenger, by the electric locomotives.

It was shown, from the few trials made with passenger trains, that not only could the guaranteed speed of thirty miles an hour be attained, but speeds of thirty-five and forty miles, with 500 ton trains, were possible. An exhibition of high speed was made with the locomotive running light up the 0.8 per cent. grade, and a speed of sixty-one miles per hour was attained for a short time, without the slightest trouble from trolley or motors. Several of the many exhibitions made by the locomotives in pulling heavy loads have been described in the newspapers. Probably the most striking was when two trains were coupled together and hauled through the tunnel. For some reason the freight trains had become "bunched" on the Washington division, and when they did get through they came so fast that it was decided to have the electric locomotive haul them two at a time. The first composite train, therefore, consisted of forty-four cars, loaded with coal and lumber, two regular steam freight engines and a steam "pusher" engine. The whole weight was approximately 1,900 tons, and was equivalent to about fifty-two loaded cars. The steam locomotives did no work to assist the electric locomotive. The start was made easily and gradually, but when the train was in the tunnel and entirely on the grade the steady, heavy pull was too severe on a defective coupling near the head of the train, and it parted. After coupling together again, the electric locomotive started the heavy train, with all drawbars stretched —no slack in the train—and accelerated it to a speed of twelve miles an hour, without slipping a wheel, and in every way with the greatest ease. It reminded one of the start of an ocean steamship, so noiseless was it and free from any manifestations other than those of mighty power. The current recorded on the ammeter was about 2,200 amperes during the acceleration period, and after the train was up to speed it settled down to about 1,800 amperes. The voltage on the line

was 625. By reading the amperes we were able to readily compute the drawbar pull, and found it to be about 63,000 pounds. All four motors were in series, and we were, therefore, getting the maximum pull for that current.

It may be of interest to steam railway engineers to know how

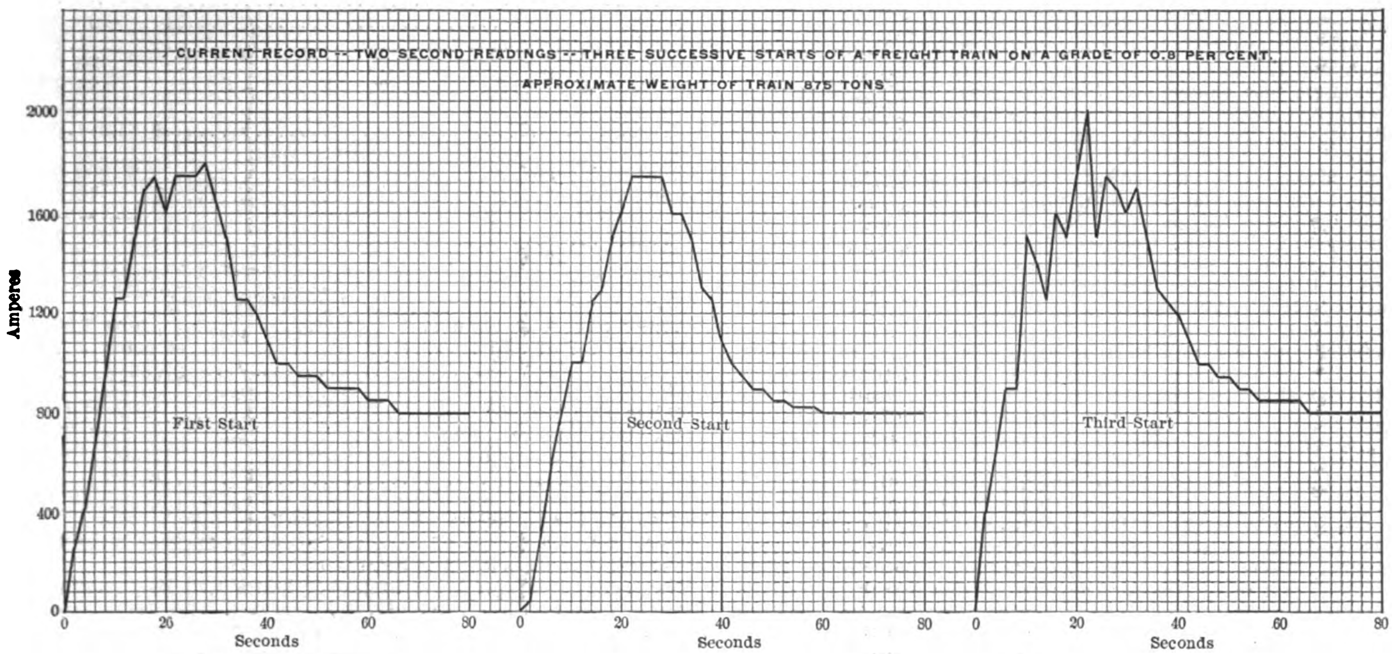
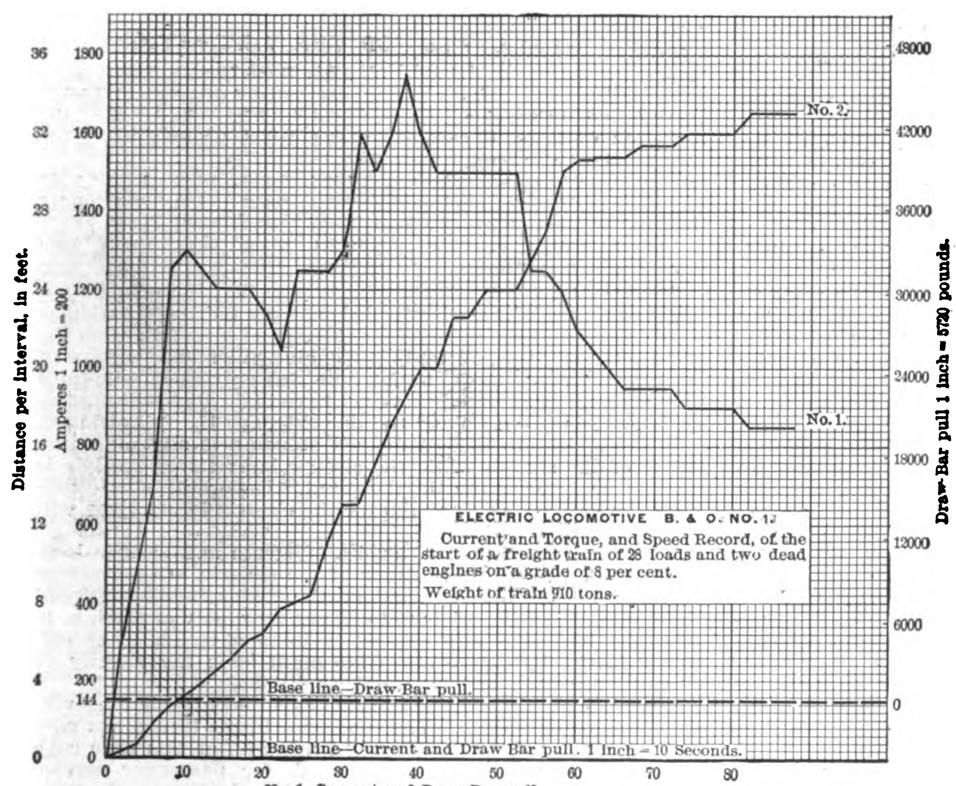


FIG. 1.

we determined the drawbar pull exerted for each ampere of current put into the locomotive. The Pennsylvania Railroad Company's dynamometer car was secured and coupled in between the electric locomotive and a train of known weight.

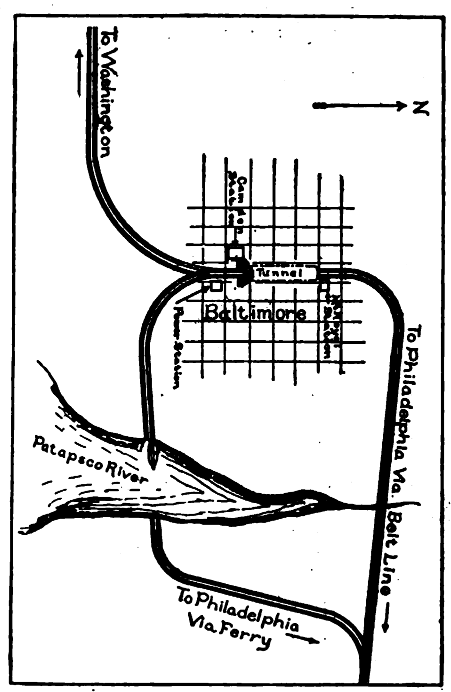


No. 1. Current and Draw-Bar pull.
No. 2. Acceleration—feet per interval of two seconds.

FIG. 2.

The weight of each car in pounds had been accurately determined beforehand. The regular two-mile haul up grade was then made. When the train was in the tunnel on the grade the pull was uniform, as was shown in the diagrams taken on the dynamometer car.

When no drawbar pull was recorded the pen rested on base line No. 1. The height or ordinate of the irregular curve at any point represented the drawbar pull at that instant. Measuring the same in inches and subtracting a constant and then multiplying by 4,000, gave the drawbar pull in pounds, i. e., every inch in height represented 4,000 pounds. The paper traveled under the pen at a rate proportional to that of the train. An irregular line marked No. 2, above the base line, was the planimeter record, from which was determined the



MAP OF BALTIMORE TUNNEL.

mean pull for any time. Having, then, the velocity, or the feet per minute and the mean pounds pull exerted during any period, we readily obtained the horse-power developed.

Another line on the diagram showed the chronograph record, each of the small offsets in the line occurring every five sec-

onds. For every hundred feet the train moved, the paper moved an inch. The distance in inches between any two of these offsets gave us readily the velocity of the train. Another line represented the time readings of current and voltage which were taken in the locomotive, a push-button in the locomotive being electrically connected with this recording apparatus. These readings were numbered, so it was easy to tell the current at any time and location. Still another line showed a record of the different stations in the tunnel. From this we determined the location of the train at any time.

The first test showed (a) how the start was made on the down grade leading to the tunnel; (b) how after the train was fully started, the drawbar pull dropped off; then (c) how it gradually increased as the train came on to the 0.8 per cent. grade in the tunnel; and (d) after the train was wholly on the grade, how even the pull was, until near the stop, when the grade increases 1.2 per cent. Mr. Dunbar, the official of the Pennsylvania Railroad Company in charge of the car, showed some diagrams of steam locomotive work under similar conditions, and it was seen that their amplitude of vibrations was considerably greater than those of the electric locomotive. This was undoubtedly due to the absence of the angle crank on the electric locomotive, and because its pull is uniform throughout the entire revolution of the armature. Most of the vibrations of the pen shown on these curves were due to vibrations of the dynamometer car which was mounted on a single truck.

From test No. 1 we obtained the total drawbar pull in pounds, and knowing the weight of the train, we found the drawbar pull to be 22. + lbs. per ton of weight. Subtracting the grade pull, which, in the case of an 0.8 per cent. grade, is sixteen pounds, we obtained 6. + lbs. per ton as the train resistance. This confirms the usual allowances made for freight train resistance. These observations were taken in September, 1895, on a very hot day. During the past winter months the train resistance has increased, due, no doubt, to greater journal friction, caused by thickened lubricants, and we find it to be from our records about 20 per cent. to 30 per cent. greater than in September.

Test No. 2 was made after we had switched off six cars. The run was made under similar conditions and the same character of observations was made. The difference in drawbar pull of the two trains would naturally be the drawbar pull necessary for the six cars switched off. We had their exact weight, and were thus again able to find what the drawbar pull per ton was. It was a check on our first figure and was very close to it, the slight difference we found being due to one brake on the six cars being partially set during the first run and unknown to any one.

We had the readings of current during the first run, also during the second. The difference of these should show the current required to haul six cars switched off. Dividing the difference in the drawbar pulls recorded in the two tests by the difference in current recorded, gives us directly the net drawbar pull in pounds per ampere of current. This was 28.6 lbs.

It will, of course, be noted that by this method we eliminated the current required to drive the locomotive. To determine how much this was, and to check our conclusions, we divided the drawbar pull in pounds recorded in the first by 28.6 and thus obtained the current that should exert that net drawbar pull. Subtracting this current from the current actually recorded on the locomotive would give the current required to drive the locomotive. We found it took 144 amperes. As a further check we figured similarly for the second test and obtained precisely the same, i. e., 144 amperes. So at any time now when hauling a train with the four motors in series if we take the current indicated on the amperemeter and subtract the 144 amperes needed for the locomotive, and multiply the remainder by 28.6, we have the total net drawbar pull in pounds, and if we divide this by the drawbar pull per ton we get the tons of load we are pulling.

From the results obtained above we were able to show the current and drawbar pull at any moment while accelerating a train. The curves (Figs. 1 and 2) explain themselves very fully.

The acceleration curve, (Fig. 2), was obtained by dropping doughballs every two seconds, and they were the markers used in determining the distances traveled in each interval, as shown on the curves in Fig. 2.

When it comes to a comparison of the economy of electric and steam locomotives it is readily seen that it is a difficult undertaking, knowing as we do the figures of only a single isolated electric plant operating under special conditions and for a comparatively short time. One great incidental advantage of electric locomotives in tunnel service is that they are smokeless. This is an important hygienic consideration, but one which can hardly be computed in dollars and cents. But it may be of general interest to know how the actual operating expenses per engine mile of the electric locomotives during October, 1895, compare with those of a prominent and large Eastern railway for the same month.

For the operation of the Baltimore and Ohio tunnel power house for the month of October, 1895, the itemized expenses were as follows:

Labor	$1,345.70
Coal ($1.35 per ton)	400.96
Oil and waste	151.26
Water	50.66
Maintenance	25.42
Total	$1,974.00

The expense of electric locomotives was:

Motor engineers	$ 200.00
Oil and waste	12.16
Total	$ 212.16
Total expense	$2,186.16

There were hauled through the tunnel 353 trains

Average weight of train	tons	1,095
Average time of trip	minutes	20
Average current	amperes	986
Distance of trip	miles	4
Total engine travel	miles	1,412
Total engine travel "idle"	miles	3,756
Actual time consumed for above service	hours	118
Idle time for month	hours	626

It is customary to consider an engine with steam up as equivalent to six engine miles for each hour it is idle, so that, for comparison, the actual mileage made by the engines must be increased $6 \times 626 = 3,756$ miles.

The large charge of labor at power house will be the same for one, two, or three locomotives in service. The items, coal, water, and maintenance, and the expense on locomotives, increase with the number of locomotives in service. If we assume this increase to be proportional, the total expense and cost per engine mile are as follows:

	Total Cost.	En. miles.	Cost per en. mile.
For one locomotive	$2,186.16	5,168	$.423
For two locomotives	2,875.36	10,336	.278
For three locomotives	3,564.56	15,504	.23

The steam railway records referred to above are for October, 1895, and may be briefly abstracted as follows:

Steam Locomotive Performance.

	East div.	West div.	Cen. div.	N.&W. div.	Entire Line.
Locomotives in service	74	57	33	28	192
Av. engine mileage in service	2,834	2,966	2,293	2,305	2,703
Average cost per engine mile—					
Passenger engines	.1926	.1666	.1629	.1552	.1765
Freight engines	.2472	.2656	.3428	.2303	.2615
Switching engines	.1489	.1659	.1828	.1425	.1577
Work engines	.2391	.2258	.2617	.2169	.2351
Total engines	.2080	.2183	.2121	.1797	.2095

From the figures given above it is seen that the actual operating expenses of the electric locomotives for that particular month are about the same as for the freight locomotives on the steam railroad, i. e., 23 cents per engine mile. The service of the electric locomotives at that time was only about one-third that which it is expected they will have to do when the passenger service is taken up and the line extended the full distance.

As originally intended, a method of using to advantage the power of the station while the electric locomotives are idle is soon to be incorporated in the plant. Under the new conditions the cost per engine mile for the electric locomotives will be far under that of steam.

A comparison of the efficiencies of steam and electric locomotives shows slightly in favor of the electric. Observations made on French railways and on the Pennsylvania Railroad show that about 45 per cent., to 55 per cent. only of the i. h. p. of steam locomotives is applied to hauling trains. The efficiency of the Baltimore and Ohio plant is in the vicinity of 60 to 65 per cent. under normal conditions.

A word may be added as to our experience with the overhead conductor system. The conductor in the tunnel has now been in position for nine months. During all of this time coke burning locomotives have been used, for passenger service with the consequent presence of a good deal of gas and vapor. For the first six months about half of the conductor was constantly wet from the drip due to leaks in the masonry. This occasioned a muddy, slimy deposit over the insulators and a considerable portion of the conductor. The porcelain insulators are almost entirely obscured in some places by this deposit and that of small particles of carbon given by the locomotives.

Current was first turned on the line about three months after the tunnel structure was erected. The leak to earth was at first twenty-one amperes, but in a day or two this dropped to about four amperes—the present leakage. The inside of the conductor was coated with a combined deposit of rust and muddy sediment. Heavy currents were taken from it by the contact shoe only with difficulty and the presence of much arcing, heating and showers of sparks. It was found impracticable to run on this surface. By applications of kerosene and frequent scraping with special shoes, a direct contact of the trolley shoe with the conductor was made possible. Although a single contact shoe then worked with little or no sparking, two shoes in tandem were adopted. Their operation through the conductor is smoother, and the contact over muddy portions of it is more nearly positive. At intervals of about three weeks the conductor is treated with kerosene, and brushing shoes are run through it, about one or two trips with these brushing shoes being all that is necessary. This serves to prevent the further accumulation of rust and to remove the sediment from the contact surfaces An inspection shows a smooth surface over which the shoes run. Contact with the metal is seen to be in high spots and thin lines which are slowly increasing in extent.

No considerable sparking now occurs, except at the wet places, where it is occasioned by the presence of water and sediment. With the exception of three places, about 200 feet long, each, the conductor is at present dry.

The bolts to the arch of the tunnel are both galvanized and painted. They show no signs of rusting. The painting has, in general, protected the surface of the conductor and channels. The sides and top of the inside of the conductor are coated with rust. Most of this is hard and close grained, some of it, however, flaky. In no case is there apparent a reduction of thickness of any of the ironwork, due to rusting. Outside the tunnels the conductor is in uniformly good condition. It adapts itself to changes of temperature without trouble. The inside of the conductor is coated with rust, but in no case has there been any trouble from it. The deposit appears to be very light. There was at no time any sparking between contact shoes and conductor outside of the tunnel.

SOCIETY AND CLUB NOTES.

PHILADELPHIA ELECTRICAL TRADES ASSOCIATION.

At a meeting of the Executive Committee of the Electrical Trades Association, a committee composed of Mr. C. E. Trump, of the Novelty Electric Company; Mr. C. M. Wilkins, of Partrick & Carter Company, and Mr. A. Bournonville, of Alfred F. Moore, was appointed to confer with some of the New York houses, with a view to interesting them on the subject of mutual protection against delinquent customers. It is proposed to hold such a meeting at the Astor House on March 4.

The object of the Electrical Trades Association is to give to the various members, timely notice of such current purchasers as are becoming delinquent. Incidentally the officers have already found that it is also an assistance as a moral force in collecting outstanding accounts from honest debtors, and at the same time it gives protection against dishonest debtors. The association is chartered and has acted under eminent legal advice throughout. It is based on an association which has been in existence in the plumbing trade for several years very successfully. Realizing the benefit it has been in Philadelphia the association is desirous of co-operation with New York, Boston, Chicago and other large centers. Its membership already comprises concerns in the states of New York, Pennsylvania, New Jersey and Maryland.

THE NEW YORK ELECTRICAL SOCIETY AT THE EDISON ELM STREET STATION..

A most interesting and successful meeting of the New York Electrical Society was held at the Elm street station of the Edison Electric Illuminating Company of New York on Feb. 27. The attendance was large and representative. The chair was taken by Dr. Laudy, vice president, and a paper was read from the president, Mr. John W. Lieb, who was unfortunately kept at home by sickness. The subject matter was, however, admirably presented by Mr. A. Williams, with the aid of numerous charts. Mr. R. R. Bowker also supplemented the paper by an address of beautiful clearness and simplicity on a number of technical and commercial points connected with the local Edison system and its management. After well-deserved votes of thanks, the visitors were escorted through the station by guides, in parties of about a dozen, and were then entertained with refreshments in Mr. Bowker's reception room. Altogether, the evening was one of the most delightful and instructive character imaginable.

NATIONAL ELECTRIC LIGHT ASSOCIATION CONVENTION.

Mr. C. O. Baker, Jr., master of transportation, has issued the following notice:

The Trunk Line Association have granted a rate of a fare and one-third for the round trip from points in their territory to delegates attending the nineteenth convention of the National Electric Light Association, to be held in this city May 5, 6 and 7, 1896.

The convention will be held in a hall most admirably adapted for the purpose—in the Industrial Building, Forty-third street and Lexigton avenue, during the progress of the great electrical exposition.

NEW ENGLAND ELECTRICAL TRADE ASSOCIATION.

Representatives from a number of electrical firms met last week at Young's Hotel, Boston, and formed the New England Electrical Trade Association, for protection against bad debts and to establish a bureau of credit. These officers were chosen temporarily: President, Frank Ridlon; Vice-president, P. M. Reynolds; Treasurer, D. A. Andrews, Jr.; Executive Committee, D. A. Andrews, Jr., Chairman; P. M. Reynolds, Arthur Drew, H. B. Cram, and C. C. Allen.

The firms represented were the Pettingell-Andrews Company, Bibber, White & Co., Anchor Electric Company, Frank Ridlon Company, Boston Electric Company, Electric Gas Lighting Company, Wheeler Reflector Company, J. W. Poole, Bernstein Electric Company, and the New England Electric Supply Company.

The annual meeting for the election of officers will probably be held on the third Friday of March, at Young's Hotel.

THE ELECTRICAL ASSOCIATION OF BROOKLYN.

A meeting was held at 17 Whipple street, Brooklyn, Feb. 28, to complete the organization of the society of electricians, recently mentioned in these columns.

The meeting having been called to order, Mr. G. H. Wood was elected temporary chairman and M. R. Rodrigues acted as secretary.

The name decided upon was "The Electrical Association of Brooklyn."

The objects of the association will be the promotion and study of the arts and sciences connected with the electrical and allied industries and the welfare of those interested in the same, also the maintenance of rooms and procurement of apparatus and literature for their use.

The association will consist of associate and active members. Associate members will be those who are or have been connected with the electrical or allied industries; active members being those who possess a thorough knowledge of the electrical science.

The following were appointed to select rooms and also to act as a committee on membership: Messrs. G. H. Wood, of the Brooklyn Edison Illuminating Company; A Davidson, of the Commercial Cable Company; C. R. Underhill, of the Western Electric Company; H. Cramer, Brooklyn Edison Illuminating Company; H. E. Wadsworth, Tucker Construction Company.

Any further information regarding the association will be furnished by addressing the secretary, M. R. Rodrigues, 17 Whipple street, Brooklyn.

The next meeting of the association will be held at the Edison Building, Pearl street, Brooklyn, on Thursday evening, March 5. Practical men interested are invited to be present.

MARRIED.

CHAMBERLAIN—BRUERE.

Mr. Rufus Nutting Chamberlain, of this city, was married on Feb. 15 to Miss Marie Louise, daughter of Mr. Charles Meirs Bruere, of Cream Ridge, N. J. The happy pair, who are now on their wedding trip, have the congratulations of a host of friends. Mr. Chamberlain was recently in charge of the electric fleet at the Atlanta Exposition, and is well remembered for his successful work as electrical engineer of the big fleet at the Chicago World's Fair.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS, ISSUED FEB. 25, 1896.

Alarms and Signals:—

ELECTRIC ANNUNCIATOR. J. Kips, Yonkers, N. Y., 555,101. Filed Jan. 8, 1895.
Obviates the use of an electromagnet in the construction and operation of annunciators.

ELECTRICAL ANNUNCIATOR. F. Porath, Appleton, Wis., 555,120. Filed July 6, 1895.
An annunciator by means of which an alarm will be sounded when the water in a boiler rises above or falls below a certain level.

ELECTRIC CALL AND ALARM APPARATUS. J. P. Hartfuss, Merzig, and E. Herz, Saarbruck, Germany, 555,160. Filed Feb. 14, 1895.
Details of a system whereby an alarm may be sounded simultaneously in several stations, and means for answering the same.

ELECTRIC RAILWAY SIGNAL SYSTEM. J. Irwin, Omaha, Neb., 555,167. Filed Feb. 18, 1895.
Consists of two rotatory disks, with magnets for operating them.

FIRE AND BURGLAR ALARM. R. L. Levin, Menominee, Mich., 555,173. Filed May 25, 1895.
An electric switch arranged in proximal relation to a trip lever, and an arm attached to a pivoted switch arm and arranged in the path of the trip lever, so as to be operated thereby.

ELECTRIC SIGNALING DEVICE FOR RAILROADS. G. A. Lyncker, Munich, Germany, 555,217. Filed April 27, 1895.
Transmits a signal over the whole stretch up to the office of the next station when a train leaves a station and a signal is made at the same time at the station it started from.

Primary Batteries:—

PRIMARY BATTERY. W. A. Crowdus, Chicago, Ill., 555,303. Filed June 12, 1895.
Consists in the method of connecting the cells in series with one another.

PRIMARY BATTERY. W. A. Crowdus, Chicago, Ill., 555,304. Filed Oct. 4, 1895.
A negative element consisting of a reticulated supporting conducting plate, provided with a porous coating of baked copper oxide and a carbonized binder.

Distribution:—

ELECTRIC TRANSFORMER. W. Carter, Louisville, Ky., 555,074. Filed April 23, 1895.
Employs a primary and secondary coil and a core, the latter being of the open iron type, and consisting of a plurality of approximately horseshoe-shaped laminae of iron.

ELECTRIC LIGHTING SYSTEM. S. L. Trippe, New York, 555,192. Filed June 21, 1893.
A transferring device for changing the current from one circuit to another, and a series of shunts for neutralizing the induced current.

ELECTRIC DISTRIBUTION SYSTEM. E. C. Myrick, Providence, R. I., 555,326. Filed May 23, 1893.
Announces at any desired point when a fuse has burned out and indicates the location of the fuse box in which a fuse has thus burned out.

CONSTANT POTENTIAL ALTERNATING GENERATOR. W. K. Freeman, Fort Wayne, Ind., 555,152. Filed July 5, 1895.
The combination with a system of generator regulation embodying a pulsating current generator, a transformer having its primary in series with the working circuit of the generator, and its secondary controlling the energizing of the field of force, of a current regulator controlled by the speed of rotation of the main drive shaft interposed in said secondary circuit of the transformer, whereby the energy of the field of force is governed in accordance with both the rate of rotation of the drive shaft and the consumption of energy in the working circuit.

ALTERNATING MOTOR. N. Tesla, New York, 555,190. Filed May 15, 1888.
The combination of energizing circuits, one adapted to be connected with a source of alternating current, the other arranged in inductive relation to the said first circuit, whereby the motor will be operated by the resultant action of the two circuits.

ELECTRIC MOTOR. E. Thomson, Swampscott, Mass., 555,191. Filed Dec. 19, 1890.
The combination, in an electric motor, of a divided armature-core, two field magnets acting respectively upon the two parts of the divided armature, and means for varying or changing the relative effects of said field magnets, in proper manner to restore the speed to normal.

ARMATURE WINDING. W. H. Knight, Schenectady, N. Y., 555,216. Filed April 13, 1895.
An armature coil composed of a six-sided figure, the two halves of which lie in different but parallel planes, and are united by a portion approximately radial to the circumference of the armature-core.

BRUSH FOR DYNAMO ELECTRIC MACHINES AND MOTORS. F. W. Kreinberg, Elsey, Germany, 555,381. Filed Feb. 17, 1894.
A brush formed of a bundle of fine wires braided together and saturated with a lubricant, and a casing inclosing the wires and lubricant.

Lamps and Appurtenances:—

HANGER BOARD FOR ARC LAMPS. A. J. Oehring, Chicago, Ill., 555,112. Filed Sept. 18, 1894
An insulating non-inflammable hanger board that can not be readily broken, and an improved switch and improved binding posts for the hanger board.

ELECTRIC LAMP FOR VEHICLES. W. A. Crowdus, Chicago, Ill., 555,305. Filed Oct. 4, 1895.
Relates especially to the construction of the reflector portion and means for holding it in position.

HANGER FOR SIGNAL LANTERNS. E. R. Knowles, Middletown, Conn., 555,320. Filed Dec. 5, 1893.
Provides means enabling the lanterns to always hang vertically.

Measurement:—

ELECTRICAL MEASURING INSTRUMENT. F. von Hefner-Alteneck and H. Görges, Berlin, Germany, 555,286. Filed Nov. 25, 1895.
A solenoid instrument.

Miscellaneous:—

ELECTRIC VISUAL INDICATOR. F. W. Cole, Newton and W. M. Chapman, Needham, Mass., 555,076. Filed June 3, 1892.
The indicating surfaces or drums are actuated by springs or equivalents, and let-offs are provided for them which are operated simultaneously by an electromagnet.

SECONDARY ELECTRIC CLOCK. F. L. Gregory, Chicago, Ill., 555,090. Filed May 11, 1895.
An electro-mechanical clock system, embodying an electro-mechanical secondary clock, having actuating apparatus in circuit with the primary clock.

SCENIC THEATER APPARATUS FOR PRODUCING SUN EFFECTS. A. J. Oehring and A. L. Tucker, Chicago, Ill., 555,113. Filed May 13, 1895.
The combination, with a rotating pivoted arm, of the lamps carried on the end thereof, a screen, a traveling carriage, the lamps carried thereon, a pivoted arm, the lamps carried on the end thereof, and a screen.

CIRCUIT CONTROLLING APPARATUS FOR SCENIC THEATERS. A. J. Oehring and A. L. Tucker, Chicago, Ill., 555,114. Filed May 13, 1895.
Automatically actuated devices for controlling the circuits through the several series of translating devices employed in lighting and otherwise producing the scenic effects.

ELECTRIC WELDING INDICATOR. E. Thomson, Lynn, Mass., 555,130. Filed July 23, 1888.
An electric transformer, a counter secured to the secondary bar or circuit of such transformer, and means for actuating or controlling such counter by the current flowing in the bar.

ELECTRIC RIVETING. E. Thomson, Swampscott, Mass., 555,131. Filed Oct. 20, 1890.
Consists in making the rivet in two parts, which are placed in position in the rivet hole with their ends abutting, and are then subjected to end pressure.

TOY. J. F. Prentice, Brooklyn, N. Y., 555,181. Filed July 24, 1895.
Designed to illustrate the story of "Jonah and the Whale;" magnets are employed.

PROCESS OF MANUFACTURING WHITE LEAD BY ELECTROLYSIS. A. B. Browne, Cambridge, and E. D. Chaplin, Natick, Mass., 555,232. Filed July 2, 1894.

ELECTRICAL PROPULSION OF VESSELS. E. A. Le Sueur, Ottawa, Canada, 555,252. Filed March 26, 1894.
Consists in means by which an electrical conductor may be secured underneath the surface of the water.

ELECTRIC HEATER. J. F. McElroy, Albany, N. Y., 555,259. Filed May 31, 1895.
Constructed in such a manner that there shall be a circulating air space between the double walls.

ELECTRIC CLOCK. S. Fischer, Brooklyn, N. Y., 555,313. Filed May 10, 1895.
Consists of an electric clock, in which the pendulum is driven by electric impulses imparted to it, as from a primary battery, so as to operate a going train and a striking train.

ELECTRIC RECEPTACLE FOR FLASHING POWDER IN FLASH LIGHT BURNERS. H. E. Rathbun and F. Berby, Pawtucket, R. I., 555,332. Filed Jan. 7, 1895.
A blank cartridge for photographic purposes, provided in itself with an electric wire adapted to ignite a charge of flashing powder placed in the cartridge.

MACHINE FOR CONNECTING ELECTRIC CONDUCTORS. H. J. Savory, Somerville, Mass., 555,403. Filed April 17, 1893.
A machine for connecting a small electric conductor to a larger one, a frame, a clamping device to clamp and rigidly hold the smaller conductor and an upsetting device to upset the smaller conductor within a perforation in the large.

PROCESS OF AND APPARATUS FOR ELECTROLYTICALLY FORMING TUBULAR BODIES. I. Klein, Buda-Pesth, Austria-Hungary, 555,452. Filed Dec. 7, 1894.
Relates to the rolling of metallic deposits precipitated by galvanic process, its object being to compress and mold such metal.

Railways and Appliances:—

ELECTRIC CAR LIGHTING APPARATUS. W. Biddle, Brooklyn, N. Y., 555,068. Filed Dec. 24, 1894.
The combination with the field magnets and armature in a dynamo of a magnetic intercepter and means for moving the same endwise of the armature in proportion to the speed of the armature to intercept the lines of magnetism as the speed of the armature is increased or the reverse.

TROLLEY WHEEL SWITCH. P. A. Williams, Decatur, Ill., 555,145. Filed June 10, 1895.
Comprises a plate having grooves in its under surface extending from each side of the main wire to the corresponding side of each switch wire.

CONDUIT ELECTRIC RAILWAY. C. M. Bridges, Seattle, Wash., 555,208. Filed May 31, 1895.
Consists in the novel construction and arrangement of parts.

ELECTRIC RAILWAY. W. H. Jordan, Brooklyn, N. Y., 555,248. Filed Jan. 17, 1896.
Provides a simple system and apparatus for signaling on electric railways.

CONTACT DEVICE FOR ELECTRICALLY PROPELLED VEHICLES. E. B. W. Reichel, Gross-Lichterfelde, Germany, 555,263. Filed Aug. 15, 1895.
The combination with a horizontally extending fractional contact device, of a central revoluble contact.

UNDERGROUND CONDUCTOR SYSTEM FOR ELECTRIC RAILWAYS. C. T. H. Schwieger, Berlin, Germany, 555,266. Filed Nov. 15, 1895.
Relates to sectional conductor systems.

ELECTRIC MOTOR FOR STREET CARS. H. M. Neer, Springfield, O., 555,392. Filed April 25, 1895.
The combination with an outer casing and an inner supporting frame, track wheels having stub axles extending through said casing, and a motor supported on said frame, universal joints between said stub axles and motor shaft, and springs between said casing and axles.

ILLUMINATED SIGN FOR ELECTRICALLY DRIVEN STREET CARS. R. H. Engle, Garden Lake, N. J., 555,440. Filed March 8, 1895.
A casing having in one or more of its sides a transparent or translucent sign plate, an electric lamp projecting longitudinally into said casing from either end of the same.

SECTIONAL CONDUCTOR FOR ELECTRIC RAILWAYS. W. H. Baker, Pawtucket, R. I., 555,470. Filed March 21, 1895.
Consists in dividing the said conductor in sections, each normally disconnected from and auxiliary to the main conductor or feed-wire.

Regulation:—

ELECTRIC ELEVATOR CONTROLLER. E. P. Warner, Chicago, Ill., 555,136. Filed Oct. 29, 1892.
An arrangement of cams and cam guides for operating a reversing switch and a variable rheostat.

SYSTEM OF CONTROL FOR ELECTRIC MOTORS. E. A. Sperry, Cleveland, O., 555,291. Filed Feb. 16, 1895.
Consists in devices for automatically varying the magnetization of the field.

REGULATING ELECTRIC DISTRIBUTION SYSTEM. J. Burke, Schenectady, N. Y., 555,301. Filed Dec. 24, 1894.
Consists in supplying the circuit with current from main sources of supply of different potential and regulating the potential of the supplied current by intermediate variable sources of electro-motive force.

Telegraphs:—

TELEGRAPHIC REPEATER. L. Horton, Jr., Reading, Pa., 555,-165. Filed Dec. 14, 1895.
Certain modifications in the construction and mutual relations of the parts of the apparatus heretofore generally employed for this purpose.

Telephones:—

SHORT DISTANCE TELEPHONE COMMUNICATION. W. L. Bradshaw, Cincinnati, O., 555,073. Filed Sept. 28, 1895.
A novel means for short circuiting the receiver, whereby low resistance bell-circuit is made either way from said receiver.

TELEPHONE TRANSMITTER. A. Graham, London, England, 555,-154. Filed May 3, 1894.
A telephone transmitter of the Hunning type.

RAILWAY TELEPHONE SYSTEM. W. H. Nixon, Providence, R. I., 555,222. Filed Jan. 28, 1895.
Means for connecting a portable telephone with telephones at the ends of the line.

TELEPHONE. M. Garl, Akron, O., 555,239. Filed April 4, 1895.
The combination of a helical L-shaped spring, having attached to the free horizontal portion of said spring a diaphragm, said diaphragm being free to vibrate with the spring, an electrode and a receiver.

PATENTS ISSUED FEB. 18, 1896.

MEANS FOR SUPPORTING AND INSULATING ELECTRIC CONDUCTORS. T. T. Eckert, New York, 554,664. Filed Dec. 8, 1894.
The combination of a glass hood having an interior screw thread; an iron pin and a wooden thimble.

ELECTRIC DOOR OPERATING APPARATUS. O. H. Hicks, Chicago, Ill., 554,818. Filed Aug. 24, 1893.
Gives details of construction of mechanism actuated by electromagnets in circuit with primary batteries, for opening and closing doors.

ELECTRIC DOOR OPERATING APPARATUS. O. H. Hicks and R. F. Troy, Chicago, Ill., 554,819. Filed Aug. 8, 1895.
Similar to above.

ACTUATING MECHANISM FOR ADVERTISING DEVICES. M. M. Gillam, New York, 554,926. Filed Oct. 15, 1895.
A rotatable sign, a shaft carried by the sign, a disk secured to said shaft and electromagnet, an armature therefor, a circuit making and breaking device for energizing and de-energizing said magnet, consisting of a flexible contact strip and a lever arm traversing the same carried by the armature and mechanism controlled by said lever arm for rotating said disk.

SWITCH AND SIGNAL APPARATUS. E. H. Goodman and S. H. Stupakoff, Pittsburg, Pa., 554,927. Filed Oct. 17, 1895.
A disk provided with a notch and adapted to be operated by the signal mechanism, and two notched disks adapted to be operated, one by the switch mechanism and the other by the switch rails, the signal disk and the switch disks being so mounted as to intersect.

LEGAL NOTES.

A SUIT TO OPEN TELEPHONE LINES TO COMPETITOR.

NORWALK TELEPHONE CO. VS CENTRAL UNION AND OHIO TELEPHONE CO,

The Norwalk (Ohio) Telephone Company has just filed a petition to compel the opening of the lines of the Central Union Telephone Company by mandamus, under the common carrier law, which governs telegraph, telephone and kindred services. The Norwalk company is the new opposition local company, using the Harrison system, and desires to have the old exchange not only connect with the new, but transmit messages from its patrons to points on the Central lines outside Norwalk. The question thus raised is highly important. Mr. C. H. Gallup is the president of the Norwalk Telephone Company, which is represented by Messrs. C. P. and L. W. Wickham.

The Central Union Telephone people do not appear to have made any move yet in the matter.

ELECTRIC SWITCHES—VICTORY FOR THE BRYANT ELECTRIC CO.

Judge Townsend in the United States Circuit Court, at New Haven, Conn., has handed down a decision dismissing the bill in the suit for infringement of patent brought by O. S. Platt, against the Bryant Electric Company. The article in dispute was an electric switch which the company have been making in large quantities.

Several years ago Mr. Platt invented a switch for use on electric lights. He secured a patent on it, but it was not manufactured to any great extent at that time. In the meantime the Bryant Company obtained a switch which was somewhat similar. Mr. Platt afterwards learned that they were manufacturing what he believed was his invention and he instituted proceedings to test their right.

The Bryant Company denied that there was any infringement. They claimed that it was merely another application of old ideas. This view of the patent, it would seem, has been sustained by the Circuit Court, although the full text of the decision is not yet at hand.

The amount of royalty which Mr. Platt might have obtained had he won his case would no doubt have been very large, as the Bryant Company manufactured the switch in large numbers. It is possible that an appeal may be taken to the United States Supreme Court.

STREET CAR HEADLIGHT NOT NECESSARY.

In the Superior Court at Grand Rapids, Mich., Judge Burlingame instructed the jury to render a verdict of no cause of action in the case of Terrence McGee against the Consolidated Street Railway Company.

The plaintiff was crossing a street in 1892 when he was struck by an electric car and his left leg cut off. He sued for damages; showed that there was no headlight on the car and the jury rendered a verdict of $6,000 damages. The Supreme Court reversed the case and a carefully prepared opinion was handed down declaring that the plaintiff according to the facts shown was guilty of contributory negligence. No headlight was necessary, as the car was brilliantly lighted and carried colored lights according to the provisions of the city ordinance.

SUITS INVOLVING THE VAN DEPOELE TROLLEY SWITCH PATENT AND UNDERRUNNING TROLLEY.

The Thomson-Houston Electric Company (General Electric Company) has brought suit in the United States Court at New Haven, Conn., and applied for an injunction against the Kelsey Electric Specialty Company, of New Haven, and the Billings & Spencer Company, of Hartford. The complainant alleges infringement of the Van Depoele underrunning trolley patent and the suit is the outcome of the recent decision in favor of that patent.

Suits have also been brought by the Thomson-Houston Company against the Nuttall Manufacturing Company, the Simonds Manufacturing Company and the Westinghouse Company, on the Van Depoele patent, No. 424,695, Suspended Switch and Traveling Contacts for Electric Railways, and on patent No. 495,443, Suspended Switch and Traveling Contact for Electric Railways.

OBITUARY.

SAMUEL EDISON.

Samuel Edison, father of Thomas A. Edison, died on Feb. 26 at the home of his granddaughter, Mrs. W. A. Poyer, Norwalk, O., after an illness of several weeks. Mr. Edison was born in Nova Scotia ninety-one years ago last August, and in early manhood moved to Milan, Erie County, Ohio, going from that place to Fort Gratiot, now Port Huron, Mich., where he lived for more than forty years. He came to Norwalk just before the holidays, stopping there on his way to visit his famous son in New Jersey, intending later to go to the latter's winter home at Fort Myer, Fla.

Mr. Edison's parents came to the United States from Holland long before the Revolution, settling in New Jersey. Members of the family became prominent bankers during the Revolution. Some of their names appear on the Continental money of that time. Some members of the family were Tories, and after the war of independence emigrated to Canada.

When quite young Samuel Edison's father sent him to school at Hamilton, O. Then he learned the tailor's trade. He subsequently sailed for three years on Lake Erie. He was married in 1828. In 1838 he moved to Milan, Erie County, four miles from Norwalk, where Thomas A. Edison was born in 1847, the youngest of seven. Mr. Edison was over six feet tall and strong. His wife, who died several years ago, was buried at Port Huron. Mr. Edison's body will be taken there for burial. The house where Thomas was born is still standing in Milan, in good preservation.

PERSONAL.

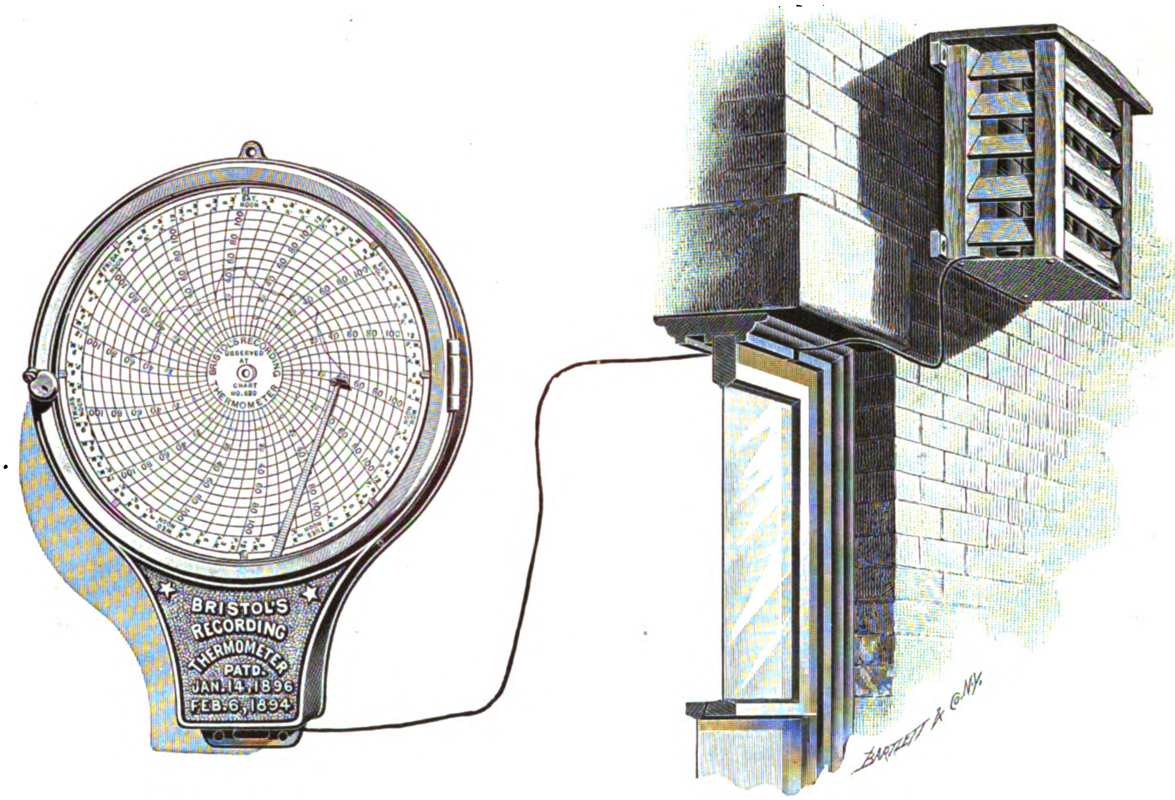
MR. F. A. LaROCHE has gone to Palm Beach, Fla., for the remainder of the winter.

Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

THE BRISTOL RECORDING THERMOMETER FOR ATMOSPHERIC RANGES OF TEMPERATURE.

The novel and especially valuable feature of the recording thermometer, illustrated in the accompanying engravings, is that the recording portion may be located at a distance of twenty-five or thirty feet from the point at which the temperature is to be measured. This makes it possible to obtain a continuous record of the outside temperature while the recorder is located at a convenient point within doors, where it may be readily observed, and its mechanism is not exposed to the detrimental influences of inclement weather. For cold storage plants, where closed rooms are to be maintained at a constant temperature for the preservation of meats, fruits and vegetables, an instrument of this kind is of great value, as the temperature may be observed without opening the doors.



FIGS. 1 AND 2.—THE BRISTOL RECORDING THERMOMETER.

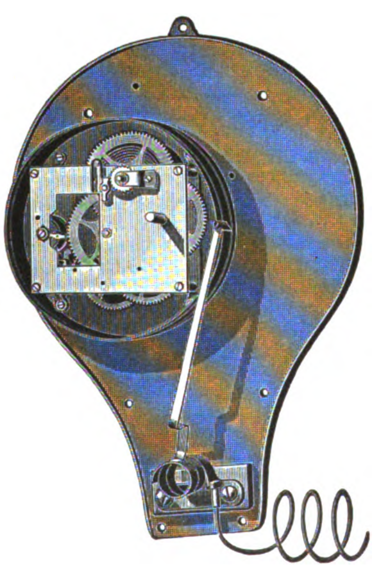


FIG 3.—THE BRISTOL RECORDING THERMOMETER.

The recording part, Fig. 1, is an application of one of Bristol's recording pressure gauges. Fig. 3 shows an interior view of the recorder, which consists of a pen arm directly attached to the free end of a tube of flattened cross-section bent into helical form. The bulb portion, Fig. 2, is placed at the point where temperature is to be measured. It consists of a series of helical tubes constructed on the same principle as that in the recorder. The helical coils are suspended in a vertical position with their lower ends free, the upper ends opening into the capillary tube connecting them with the recorder.

The system of helical tubes forming the bulb portion, the pressure tube of the recorder and the capillary connecting tube are completely filled with alcohol under pressure and permanently sealed. As the temperature rises and falls where the bulb is located, there is a corresponding expansion or contraction of the alcohol which is communicated to the recorder and registered on a seven-day chart graduated to read in degrees Fahr. Excessive pressures due to increased volume of the non-compressible liquid are provided against by the expansible form of the system of helical tubes of which the bulb is constructed.

The total volume of the bulb portion is very large, as compared with that in the pressure recorder, thus avoiding the necessity of compensating for ordinary changes of temperature in the room where the recorder is located. No correction is required for barometric changes, as only high ranges of pressure are employed.

This thermometer is being manufactured and placed on the market by the Bristol Company, of Waterbury, Conn. At 121 Liberty street, the New York branch of the company, one of the instruments may be seen in operation recording the outside temperature. The recorder is placed in the show window where it may be observed from the street.

DARLING, BROWN & SHARPES' RULES.

Under the title of "Rules," Darling, Brown & Sharpe, Providence, R. I., have published a description of their varieties of steel rules. The firm, which was originated in 1850, by Joseph R. Brown, has since that time made a specialty of the manufacture of steel rules and other instruments of precision. Since 1866 the business has been carried on under its present title. The catalogue now published treats of rules only, and embraces all forms of both standard or soft rules, and tempered rules.

BIMETALLIC WIRE.

For nearly all outdoor purposes electrical conductors are required to possess two properties, and upon these depends largely the usefulness of the conductor. These properties are conductivity and tensile strength, and whether it be in the field of telegraphy and telephony or in current transmission for light or power the same rule holds. The high conductivity of copper has made this the metal sine qua non for heavy current transmission, while the telegraph and telephone services have long since adopted and are constantly increasing their use of copper. But, unfortunately, the high conductivity of copper is accompanied by low tensile strength as compared with iron or steel, and the latter, on the other hand, are of low conductivity.

Iron or steel wire, for example, possesses about one-fifth the conductivity of copper wire. To obtain the required conductivity for ordinary uses an increased diameter is necessary. Again, iron is not durable as a conductor. On or near the seacoast its life is about three years; inland, about five years. Iron commences to deteriorate shortly after put into service. As the points of oxidation increase, so does the electrical resistance increase, and although an iron wire may be complete throughout its entire length for a considerable time after being put into use, yet its electrical resistance increases more and more as each day passes. Large poles are required for heavy iron wires, which, owing to the weight carried, must be placed close together, well braced and guyed. With the short life of iron wire it will be seen that the economy in an iron wire pole line is only in the first cost of the wire; in the end it may be found that iron is really more costly than copper.

Copper wires of large diameters are frequently employed to secure increased tensile strength, and even then the results sought are not obtained. As is well known, copper stretches under its own weight, and unless the slack is taken up at once, innumerable line troubles appear. Having wires of large diameters to carry, it follows that large poles are required, and as copper will not permit of great spans, the poles must be placed close together. The tension on the poles is very great, bracing and guying an absolute necessity, all of which adds to the cost of the line. Copper will not corrode like iron; it is a splendid conductor of electricity, but is lacking in mechanical strength.

To combine both electrical conductivity and mechanical strength it was some time since proposed to construct a compound wire, consisting of a steel core with copper shell. Wires of this type have been made, and a notable example of their use are a pair of lines of the Postal Telegraph Company between New York and Chicago. These lines were erected over ten years ago, and are still in use, with excellent results. These wires were made by depositing copper electrolytically on the steel core, but the cost involved was such that the product was too high-priced for general use.

We are glad to know, however, that the subject has been taken up again and is being vigorously pushed by the Bi-Metallic Transmission Company, who are placing on the market compound or bimetallic steel and copper wire of all sizes and for all classes of work.

Bimetallic wire partakes of the good qualities of both steel and copper—the tensile strength of the former and the conductivity of the latter. Bimetallic wire, like copper, will not corrode, and the steel core being protected by the copper sheathing, it will not oxidize like iron. The two metals of the wire are closely joined, or welded, together, forming a homogeneous mass, which permits of bends and twists in the same manner as wire of one metal.

Bimetallic wire has a greater tensile strength than wire of hard-drawn copper, and hence permits of longer spans. Having a greater tensile strength, it will be seen that wire of smaller diameter may be used, which, in turn, permits of lighter poles, fixtures, etc., and, by reason of great spans, the poles may be placed further apart. Having less exposed surface on wire, poles, etc., there is less resistance to storms of wind, rain and sleet, and consequently less liability to interruption of service.

Bimetallic wire is especially adapted for telephonic uses, owing to certain peculiar properties which it possesses, and which have been demonstrated by actual tests. Thus it is claimed that with a battery transmitter a single bimetallic wire, with an earth return, accomplishes practically the same result as is secured from a copper metallic circuit. The magneto telephone, commonly used as a receiver, is also claimed to act as a commercial long-distance telephone when used in connection with bimetallic wire in metallic circuit. Bimetallic wire is also said to require less insulation than wire of one metal, and, as less of the insulating material is needed between conductors of a cable, it follows that a greater number of conductors may be placed and operated therein. This, in turn, increases the capacity of ducts, reducing the expense of placing wires underground. It is not claimed that a bimetallic wire wholly obviates the induction so frequently heard on telephone lines, but it is claimed that when such wire is used the induction does not prevent nor interfere with conversation; that it will give a far more satisfactory service than can be obtained from a one-metal wire.

In the operation of certain systems of rapid telegraphy, especially those systems using both the alternating and direct currents, quick action of apparatus is essential for the successful operation thereof. The peculiar electrical effect in bimetallic wire produces the quick action needed, and, as a result, an improved service is said to be obtained.

The claims above cited are based on actual experiments, among them the following:

Eight miles of No. 22 B. & S. bimetallic wire was strung on the cross arms of the Western Union line along the Central Railroad of New Jersey from the Jersey City terminus of that road. This wire was not insulated at all, being fastened to the end of crossarms, mostly by mutual staples. The line was grounded at each end, was tested with telephone and found to work well. There was more or less induction, as this line of poles carries some of the hardest worked lines, leading from New York, including Wheatstone, and quadruplex; yet conversation could be carried on.

After the telephone tests, the line was tried for telegraphing, with 150 ohm relays at each end and six cells of ordinary gravity battery. The results were perfect. Then the number of cells was cut down until only one cell remained, and still the line worked perfectly, not as strong, of course, but with closer adjustment the work was first class. Wet weather did not affect the working of the line adversely; in fact, for telephoning it seemed to improve it if anything.

This wire withstood the wind and storms as well or better than the large copper wires on these same poles, and no storm has yet been able to bring it down, after several years.

The great drawback to the introduction of the wire has been its manufacture in this country. All these early experiments were made with foreign wire, but the John A. Roebling's Sons Company, of Trenton, N. J., took the matter up, and after an expenditure of considerable time and money have succeeded in making a wire absolutely perfect in every respect.

A bimetallic line of fifty-eight miles of No. 12 B. & S. has been erected between Jersey City and Trenton. This wire is put up in the same way as other telegraph wires, and is strung on the Western Union poles along the track of the Central Railroad of New Jersey to Elizabeth, and there is run over on to the largest pole line along the Pennsylvania Railroad to Trenton. This bimetallic wire is strung in this way to give it as severe a test for induction as possible. While there is a good deal of induction, still conversation can be carried on telephonically over this line with ease and comfort, while telegraphic messages have been sent between Jersey City and Trenton with 150 ohm relays at each end, with a single cell of dry battery, and not a dot was lost, nor was there any indication of lag.

The great conductivity, combined with strength, makes the bimetallic wire specially adapted for light and power distribution, and particularly for trolley wires, where a wire with little stretch is so desirable.

The bimetallic wire is patented to Mr. W. H. Eckert, the president of the Bi-Metallic Transmission Company, whose offices are in the Havemeyer Building, New York.

NEW METROPOLITAN TELEPHONE FACILITIES.

Owing to the large increase in the number of subscribers brought about by the adoption of the message rate system, by the Metropolitan Telephone Company, the establishment of an up-town office for the contract department has been decided on. This branch has been located at the Thirty-eighth street exchange of the company, No. 113 West, on that street. A large proportion of the new subscribers taken on lately by the company reside or do business in the upper part of the city, and it is believed that present, as well as prospective customers will welcome the new facilities, enabling them to carry on speedily and conveniently all negotiations regarding telephone service. It is worthy of note that during 1895, the Metropolitan Company, despite the terrible dullness in general business, enjoyed an increase of no less than 35 per cent. in the number of its subscribers, a growth attributable primarily, of course, to the message rate system, but due in no small degree to the intelligent and progressive work of the contract department of the company, under the management of Mr. Thomas H. Mack.

THE WESTERN ELECTRIC COMPANY are advertising the P. & S. china sockets. This is a new departure in this line, being composed entirely of china, which removes all danger of short circuiting in shell or base.

TIN SHADE FOR INCANDESCENT LAMPS.

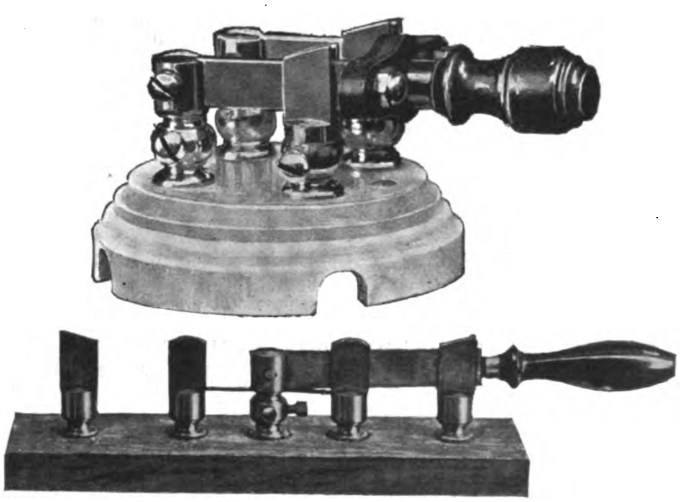
WE illustrate in the accompanying engraving the tin lamp shade manufactured by Messrs. Vallee Bros. & Co., of Philadelphia. These shades are made in two styles. Style No. 1

VALLEE BROS. & CO'S. TIN LAMP SHADE.

has an outside finish of imitation brass and the inside a bright polish. Style No. 2 has an outside finish of green paint and white enamel on the inside.

DAVIS KNIFE SWITCHES.

The Electric Railway Switch and Supply Company, of Springfield, Mass., have recently got out a very complete line of knife switches, single, double and triple pole, and single and double throw, which are meeting with favor, owing to the excellence of the workmanship, and the high grade quality of the material used. They are made in sizes from 15 amperes to



DAVIS KNIFE SWITCHES.

1,000 amperes, and are made with hard rolled copper blades, best spring copper clips, and are mounted on black polished slate or porcelain, as may be desired. This company are making a specialty at present of their "Infant" switch, as shown in the accompanying illustration, and have had a large demade for it. We show also another type.

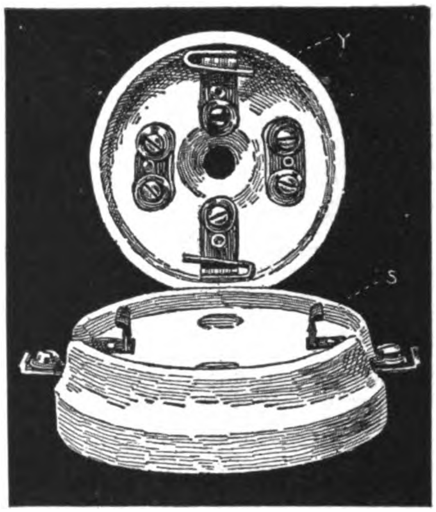
"A FEW BUILDINGS."

Under the above title the Simplex Electrical Company, of Boston, have issued a very handsome pamphlet, illustrating their work. It contains a large number of fine cuts, showing various edifices in which their wires and cables have been installed in all parts of the country. It is a very striking demonstration. Supplementary to this are a number of strong testimonials on the subect of the Simplex insulation, as well as an imposing list of buildings with the number of lights wired for. This book of good deeds was compiled by Mr. Hixson, the Western selling agent for Simplex, who has his headquarters in the Monadnock, Chicago.

THE C. D. ROSETTE.

This new rosette is manufactured by the Chapin Douglas Electric Company, 136 Liberty street, New York. Care has been taken in the general design to produce a rosette that can be quickly put up and wired, resulting in economy for the contractor.

It will be noticed that there is a yielding arm Y in the cap, and this contacts on the projecting piece in the base under the shoulder S. The open end of the arm presses against the face of the projecting piece insuring a firm contact. The cap is



THE C. & D. CEILING ROSETTE.

supported by the top of the yielding arm, resting on the shoulder S of the projecting piece, so that the rosette is not held by the contact face.

A stop pin stops the yielding arms at the right place and as they are adjustable it makes a rosette with adjustable contacts. The caps are interchangeable.

Space has been given in the location of the binding screws for the fuse links and on the base the porcelain covers the joint to protect the inside from dust and moisture. The "C. D." rosette is made in round and square base patterns.

ADVERTISERS' HINTS.

BOWERS BROS. are the headquarters in the West for Mica in its various forms. They are also agents for the Billings & Spencer drop-forge copper segments. They carry a large stock and make prompt shipments.

ANOTHER LARGE INSTALLATION of the Goubert feedwater heaters and Stratton separators has lately been made in the plant of the Portland (Me.) Electric Railways. Comment is unnecessary, as experience has shown them to be above criticism.

THE CALCULAGRAPH COMPANY have something to say about the manufacturer and the small boy, and more especially the latter's possibilities with a calculagraph. They explain how much time is saved and errors avoided.

THE ELECTRIC APPLIANCE COMPANY remind users of lamps that it is "never too early" to learn that the Packard is the best.

SEVENTY-FIVE TO 80 PER CENT. EFFICIENCY is the claim made for the Hogan boiler by its manufacturers, the Hogan Boiler Company of Middletown, N. Y. They say they are ready to substantiate this at any time.

EXPERIMENTERS WITH X-RAYS will be glad to know they may obtain Crookes tubes of any size from the Orient Electric Company, Chicago.

BRUNT & THOMPSON, East Liverpool, Ohio, are introducing a white porcelain wiring tube. It is made in lengths from two and one-half inches to three feet, affording great convenience in laying.

ELECTRIC CIVIL SERVICE EXAMINATION.

On March 6, at 10 a. m., an examination will be held for inspectors of electrical wires and appliances in the Fire Department. Persons desiring to enter this examination should apply for application blanks to the secretary of the Civil Service Board, Mr. William Briscoe, new Criminal Court Building, White and Centre streets, this city.

Department News Items will be found in advertising pages.

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Electrical Engineer.

Vol. XXI. MARCH 11, 1896. No. 410.

Electric Lighting.

SCIAGRAPHIC EXPERIMENTS.

BY

W. M. Stine

IN common with many experimenters, the writer tested his collection of Crookes tube and found himself the fortunate possessor of one of the most efficient pieces of apparatus for prosecuting the new photography that is just now engaging the attention of the scientific world. It was not until February 17 that other duties permitted giving marked attention to such experiments. Believing that the more sensational features were being developed elsewhere, the investigations in the laboratories of Armour Institute of Technology were directed rather towards the character of the new radiant.

At the outset, feeling the need of some expressive term descriptive of such phenomena, the writer ventured to coin the word "sciagraphy" from two well-known Greek words. This term was first proposed in a communication to the "Western Electrician," under date of February 15, and subsequently employed in interviews given the daily press. With such explanation the term will be used in the following article.

The Crookes tube was one of the variety showing a Maltese cross on the bulb. It was excited off a Carpentier induction coil, capable of yielding an 8-inch spark, the current being obtained from a large bank of storage batteries.

Among the first points investigated was the influence of the interrupter. The coil was provided with the familiar mercury make-and-break and also a rapid interrupter. The mercurial make-and-break gave very good results, but the small interrupter was found the more reliable and seemed to shorten the time of exposure. A contact-maker, giving two interruptions to the current per revolution was also tested. This was driven by a motor and a condenser capacity of fourteen microfarads connected across the brushes. Owing to the large capacity of the condenser, a heavy current could be broken without marked sparking. The circuit breaker was tested at speeds ranging from 500 to 4,000 per minute, to note the influence on the time of exposure. The best results were obtained at the lowest speed mentioned. At high speed the admittance of the coil was too low, owing to its large time-constant. As no especial advantage could be noted when using the circuit breaker, it was abandoned for the vibrating interrupter. This point is noted in detail, since so many experimenters seem to prefer such cumbersome devices, but they are, in reality, unnecessary.

At first, many physicists seemed inclined to attribute the production of the sciagraph to the influence of ultra-violet rays, but some unpublished investigations of the writer's seem to so strongly confirm Röntgen's longitudinal vibration theory that the present tests were especially directed toward the proof or disproof of the existence of ultraviolet waves as the active agent. To this end the relative speed of dry plates towards light and the X-rays was compared. In common with other investigators, the most rapid dry plates were at first used. An exposure was then made on a slow plate, indicating no perceptible difference in the density of the negative and length of exposure. To examine the matter more critically, two plates, a rapid Seeds 27 X and a slow Carbutt B 16 plate were exposed side by side for 45 minutes. The development was completed within a few minutes, both negatives coming out with equal speed and density. The negatives were as dense and sharp as if fully exposed in bright sunlight. The test was repeated under the same conditions and with the same results. In short, we could not then, and have not since, been able to detect that the light speed of dry plates has any influence on the time of exposure to the X-rays.

These experiments were made on Feb. 18 and promptly reported, and we believe we were the first to clearly point out such facts. Since then we have preferred the use of slow plates, as they are less liable to chemical fog and give clearer shadows and sharper contrasts. This experiment of itself would seem to indicate that ultraviolet rays had nothing directly to do with the phenomena in question, since the light speed of a plate is determined by its special reference to the actinic or ultraviolet rays.

Singularly enough, the experiment also contradicts an observation made by Röntgen in his original paper. He there states the effect on the dry plate may be due to fluorescence on the plate itself established by the action of the X-rays. Were this the case, since fluorescence is of the character of transverse light waves, the sensibility of the dry plate would be the same towards the Crookes tube as light itself.

The influence of external electrodes has come in for a large share of attention in such connection. While experimenting with these, a curious phenomenon was noticed. It has been universally held that in the action of the Crookes tubes the streams of electrified particles proceed outward from the cathode alone. Mr. Perrin, in a recent communication to "Nature,"[1] has proven that both cathode and anode streams exist simultaneously. If a tube contain an object in the path of the streams, a shadow always shows opposite the cathode when the internal electrodes are connected to the coil. We found this was still the case when two external electrodes were employed. We discovered, however, that when one external and one internal electrode were connected to the coil, the shadow remained constant in position opposite the internal electrode, whether this was the positive or negative pole. Under such circumstances, the anode and cathode streams seem to be identical. The fact, if ever noted at all, has not been generally stated in the literature of the Crookes tube.

So much has been stated pro and con concerning incandescent lamp bulbs as a source of the X-rays that our results may be of interest. Many lamps of the same and of different makes were tested, and only one produced a true sciagraph, though the negative was a weak one. In this case the filament was the cathode, the anode being a piece of tinfoil pasted on the outside of the bulb. As a conclusion it may be stated that the vacuum of the ordinary incandescent lamp is too low for satisfactory sciagraphy.

A further crucial test was planned to show the character of the vibrations. The behavior of tourmaline plates towards light waves is well known. When placed in coincidence, light polarized in one plane passes freely through them, but if they be turned so that their axes are in quadrature, they practically stop out all light. It was first necessary to test the transparency of tourmaline towards the new radiant. An exposure of 45 minutes showed the plates were sufficiently transparent for the purpose. The tourmalines were clamped in position for maximum light transmission, and exposed over a plate for 90 minutes. They were then crossed to opaque position and submitted to a like exposure. Two excellent negatives were then obtained, which, upon comparison, showed the X-rays had passed through the tourmaline with equal freedom in each case. Though such a test may not be regarded as finally settling this disputed point, when taken in connection with the effect on dry plates of various sensitiveness, it reasonably proves that whatever the X-rays may be, they are not transverse in character. In fact, the ultraviolet wave theory cannot be longer entertained by any one who has given these phenomena experimental attention.

Though sciagraphs of a sensational character have grown somewhat commonplace, we may be pardoned for presenting another ghostly hand to the public. Two rather successful prior attempts indicated the necessary details for procedure. The result of a third attempt is shown in Fig. 1. An 8 x 10 slow Carbutt plate was carefully folded in cloth, and the subject's hand bandaged over it. The exposure lasted two hours, but

[1] Republished in "The Electrical Engineer," Feb. 26, 1895.

the interrupter breaking down soon after the exposure began, the tube was poorly excited, else the exposure might have been materially shortened. The remarkable clearness of the negative may justfy its use in the present article. The negative from which Fig. 2 is reproduced was the sharpest one we

FIG. 1.

have been able to make. As a negative it is perfect in every respect, the density, sharpness of detail and the clear shadows rivaling the best results obtained by sunlight. This, too, was taken on a slow Carbutt plate. The larger rule was an ordinary boxwood brass-bound one. In the cut the rivets passing through the wood show with singular clearness. The peculi-

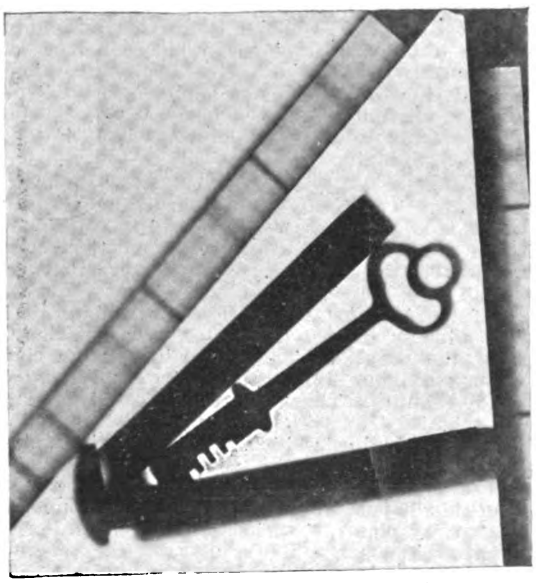


FIG. 2.

arity is that even the graduations were reproduced. Such markings are usually filled with black paint, whose opacity is here clearly indicated. An ivory caliper rule also lay on the plate. For the length of exposure, about one hour, the ivory and metal seem equally opaque. In Fig. 3 two nails and a wood screw driven into the sides of a half-inch oak strip are shown, as well as the grain of the wood. A generalization may be safely made to the effect that animal and vegetable tissues are relatively quite transparent, while mineral and metallic substances are opaque.

Naturally, various light sources were examined for the presence of X-rays. Sunlight gave a negative result, and the arc light as well. So many have fallen into error at this point that it may not be amiss to particularize. It was reported by an English periodical that a sciagraph had been made by burning magnesium ribbon over a covered plate, by a number in this country that sciagraphs had been obtained with the arc light, etc. All our tests of this nature were very carefully made, and yielded clearly negative results, the arc lamp being tested with

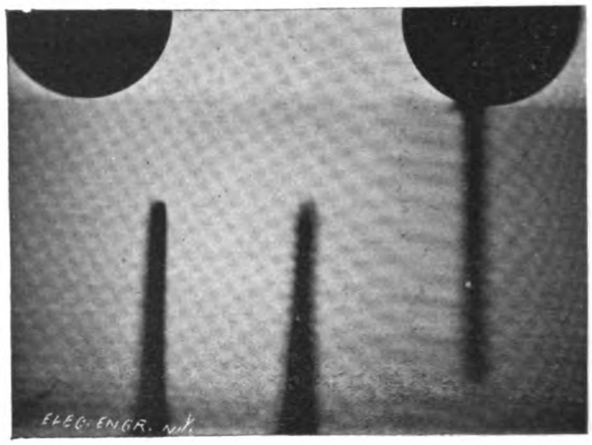


FIG. 3.

especial diligence. The error is readily explained. A plate insufficiently protected is fogged chemically when exposed to stray light, and a light opaque object lying on the plate would impress a distinct shadow. The results already noted have doubtless been of this character. Those experienced in photography well know how difficult it is to keep dry plates from fogging. The so-called magnetic sciagraphs are to be accounted for in the same way. The true test in such cases is to employ an object containing parts opaque and transparent to X-rays, though the object as a whole is opaque to light; for example, a lead pencil or nails in a strip of wood.

A more fruitful source of error has been the use of metallic plates in air. It is safe to state, that in spite of all the reputed results, that not one true sciagraph has been thus obtained; they have been of the character of electrographs. The effect

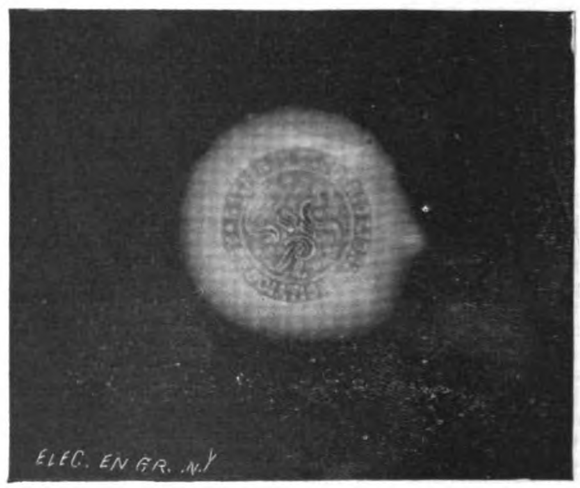


FIG. 4.

of static charges on a dry plate has been fully known for years. Static charges from plates attached to induction coils, Leyden jars, dynamo belts, etc., can be readily made to yield marked effects on photographic plates, even when these are thoroughly covered with cloth, wood, or pasteboard. As in the case of negatives made through fogging, very deceptive outlines are produced, but the experienced eye can readily detect the electrograph from the true sciagraph. The electrograph usually shows a dark object on a clear background; the scia-

graph always shows a more or less clear shadow on a dark background. In some cases the electrograph may closely simulate the sciagraph. In Fig. 4, which is an electrograph of a metallic button, these characteristics are strongly marked, especially if the cut be contrasted with Figs. 2 and 3. So far, true sciagraphs have only been obtained by the use of some modification of the Crookes tube. It is interesting in this connection to note that the electrograph is the result of an electrolytic action on the silver salts in the film of the dry plate. This fact may have a possible bearing on the explanation of the Röntgen phenomena.

The results with aluminum-stopped tubes undoubtedly show the cathode to be the prime source of the X-rays. The penumbra shadows when the object is a little distant from the dry plate, indicate, if such penumbra are plotted back, that the fluorescent bulb is at least a secondary source of the rays. This is in confirmation of Röntgen's original observations. What part does the fluorescence play in such cases? The yellowish-green fluorescence of German glass is due to the uranium it contains. Thinking the particular vibration period of luminescent uranium might have something to do with the phenomenon, the following experiments were tried: A pair of carbons were soaked in a solution of uranium nitrate and a plate exposed to the arc produced between them. A flash powder containing uranium nitrate was fired in considerable quantities near a protected plate. A large cube of brilliantly fluorescent glass was excited with the focused light from the arc lamp, and a plate placed near it. Then another test was made under the same conditions, the cube in this case being constantly charged by a static machine. In no case could the slightest trace of the X-rays be detected. Many other lines of investigation have been examined, and, in passing, we may mention that both the luminous and non-luminous gas flames are practically transparent to X-rays.

It would be rash indeed, at the present stage of experimental evidence, to make strong assertions concerning the production of sciagraphs or the ultimate character of the X-rays; yet our experiments seem to justify us in making some observations. A Crookes tube, to produce sciagraphs, must have an extremely high vacuum, so high that none but the faintest trace of purple light is seen around the anode. The successful tube also shows a decided green fluorescence, while those that fail have a strongly marked yellow cast. A tube improves greatly with use; at the same time the purple light grows less and less perceptible. A tube becomes more active after several hours' constant excitation, provided the current is not reversed. If a tube is allowed to remain idle for several days, it is less active, and the purple light is more marked. These facts may probably be explained by the occlusion in the anode of a portion of the gas present in the tube, thus enhancing the vacuum.

The effect of the X-rays on the dry plate differs radically from that of light. If true ether longitudinal vibrations exist, they must be present in Geissler tubes and all light sources. But the sciagraph does not seem to be the result alone of molecular bombardment by longitudinal vibrations, but rather partakes of the nature of electrolysis. The seat of the effect may be in the molecules containing a charge of static electricity and vibrating with, say, the frequency of green fluorescent or ultraviolet light waves. But would not the Faraday induction tubes concentrate to some extent, at least, on conducting substances, such as metals placed on the dry plate? In the absence of longitudinal ether waves this may be granted. It has been recently stated by a European authority that longitudinal vibrations would follow such induction stress lines. However, sciagraphic negatives disprove such conclusions, for the X-rays seem to travel radially. It more nearly corresponds with the facts to state that should we be here dealing with a species of electrolysis, the induction stress will rather follow and coincide with the longitudinal waves. It will not do to implicitly follow the solution of a particular differential equation before the elements on which such an equation can be based are more clearly established. J. J. Thomson and others have already shown that the X-rays neutralize either positive or negative static charges. But it more fully accords with observed effects to suppose the electric energy is immediately transformed into molecular heat energy. A Geissler tube thus as truly produces the X-rays as the Crookes, but owing to the presence of a great number of charged molecules they are absorbed within the tube itself. The efficient tube is then one in which the free molecular path extends from the cathode to the walls of the bulb, and, further, is not heavily coated on the interior with a static charge.

MANIFOLDING BY CATHODE RAYS.

BY

Elihu Thomson

In order to test the effect of Röntgen rays in producing simultaneously a number of impressions of the shadow of the same object, the experiment described below was made. It

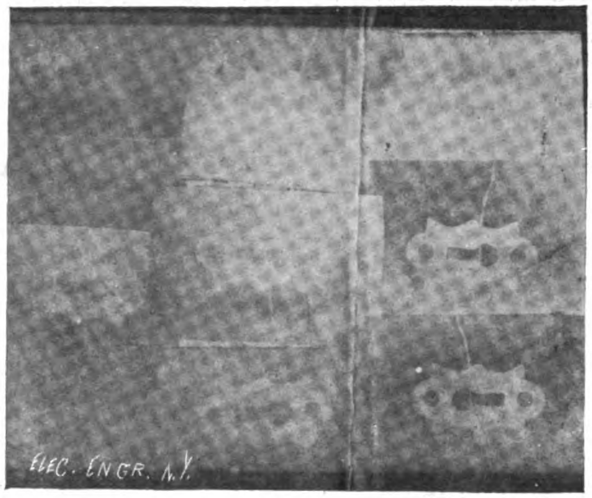


FIG. 1—MULTIPLE CATHODOGRAPHS.

had been found in a preliminary trial that a sensitive plate enclosed in its plate holder folded together with several thicknesses of bromide of silver paper (Eastman's) was strongly impressed through the several thicknesses and at the same time each of the layers received a more feeble impression. In the experiment now to be noted there existed below the Crookes tube the following in regular succession: 1. The object, a keyhole escutcheon of iron. 2. One thickness of heavy yellow paper. 3. One thickness of pasteboard (of box enclosing plate) and within the box. 4. One layer black paper. 5. Two layers of albumen print sensitized paper. 6. Two of célerité printing paper. 7. Two of platinum printing paper. 8. One of célerité printing paper. 9. One sheet thin celluloid. 10. Six layers of sensitive bromide paper. 11. Four layers of sensitive

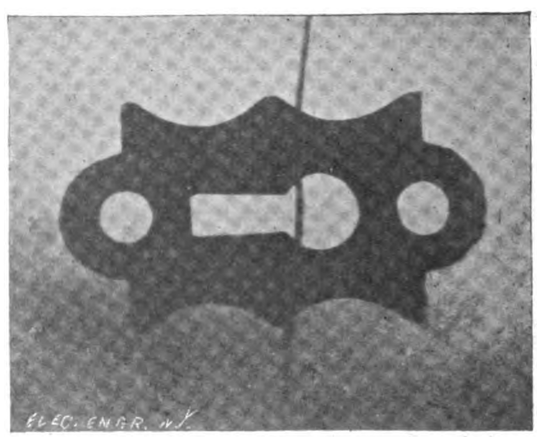


FIG. 2.

bromide paper (heavy). 12. Three layers of black paper. 13. A sensitive glass plate (dry gelatine) with its face up.

Here, then, were twenty-four layers above the plate, including the pasteboard.

The result of the exposure to cathode rays developed in the Crookes tube by about 1,200 discharges of the condenser jars of a small Wimshurst machine gave as a result a strong impression on the glass plate and weaker but perfectly distinct impressions on each of the bromide paper layers. Neither the albumen nor the célerité, nor the platinum papers, which were merely printing papers, were impressed to any discoverable

degree. Had they been bromide they would all have been affected.

The experiment shows that plates for use with cathode rays should have with the ordinary materials, dense thick films, rich in sensitive substances, such as bromide of silver, or that the proportion of material in a plate highly sensitive to cathode rays is not great. The fact that the impressions on the bromide paper were weak, although it was much more favorably situated for a strong impression than the glass plate, is easily accounted for when the relatively thin film ordinarily carried by paper is borne in mind. Could all the sensitive material of the many layers of paper which could easily be impressed at one time, be collected together in one film a dense picture would be obtained at once and from very short exposures.

I think that I have found indications of its being a fact that in cathode pictures, however thin, there is complete detail present, and that an intensifying process which would build up a very thin weak impression need not, as is often the case in ordinary photography, fail to bring out detail. Indeed, by applying the ordinary intensifying processes, details which have been absolutely undiscoverable have shown out distinctly.

STEREOSCOPIC ROENTGEN PICTURES.

BY ELIHU THOMSON.

WHILE experimenting with the making of shadow pictures, it occurred to the writer that it would be desirable to secure some indication of the position in space of various embedded solid objects, or, in other words, to obtain a pair of pictures which, when placed in a stereoscope would show solidity. This would manifestly be useful in surgical examinations, as the true relations in space of the parts of a bone, or of a foreign body and the bone would become evident. The ordinary Röntgen pictures are simple shadows on a plane surface. It is impossible to tell from such a shadow whether one object or part of an object is front or back of another. There is, however, no difficulty in determining the real positions when resort is had to the production of stereoscopic shadow pictures.

The first trial made by the author was completely successful, objects appearing in high relief. The process consists simply in exposing a covered plate in the ordinary way and repeating this with the objects and Crookes tube relatively displaced somewhat from the first position. The rays thus pass through the objects in two somewhat different directions, a record of the shadows being made for each direction. Prints from the negatives so produced are mounted for use in the stereoscope. The effect is very curious. A cork or block or wood having nails or screws driven into it in various directions is clearly shown and the screws or nails in their proper positions. When two heavily insulated wires twisted together constitute the object, the metal wires alone are seen, but standing apart in space, one around the other.

The bones of two superposed figures are to be seen in their correct positions. The complete skeleton of a mouse or other small animal may thus be recorded so as to be seen in relief, each bone in its proper space relation to the others.

It may be possible as a development of the use of Röntgen rays stereoscopically to arrange two fluorescent screens, or even a single screen, to be viewed by the eyes and receive the image or shadow in such manner as to produce the stereoscopic effect; thus, if the Crookes tube have two cathodes a distance apart, which are connected to the electric source alternately, and with considerable rapidity, while small shutters are synchronously opened and closed before each eye, respectively, one of the eyes would at all times receive the impression given by the rays from one of the cathodes, while the other eye would always receive the impression produced by the rays from the other cathode, and thus stereoscopic observations would be the result.

This method of producing the stereoscopic effect is similar to one which has been tried and used successfully in stereopticon work, two lanterns being arranged to throw upon the same screen in nearly superimposed positions two slides, which are stereoscopic in their relation to each other. A set of diaphragms were arranged, passing in front of the lantern tubes synchronously with similar diaphragms, passing before the eyes of the spectators, whereby each eye always received its appropriate image on the screen, the result being to give solidity to the scene depicted.

FLUSHING, L. I.—The Flushing Electric Light and Power Company has placed an order with the Ames Manufacturing Company, of Oswego, N. Y., for an engine of 190-horse-power to be delivered at once.

SHADOW PICTURES FROM THE ARC AND SUNLIGHT.

BY W. H. FREEDMAN, E. E.

AS a result of the most wonderful scientific discovery by Professor Röntgen and the widespread attention it has received, the thought occurred to the writer whether the same or similar effects could not be obtained from other sources of light instead of being produced only by the peculiar conditions set up by an electric discharge in a Crookes tube.

Together with Mr. C. T. Rittenhouse, Fellow in Electricity at Columbia College, an investigation was begun (since continued single-handed) obtaining several interesting results, entirely at variance, however, with those claimed by Mr. J. Hart Robertson in the issue of "The Electrical Engineer" of Feb. 19, 1896.

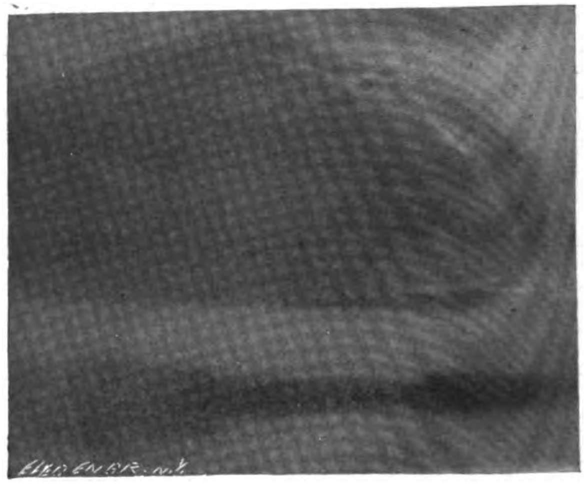


FIG. 1.—AN ARC LIGHT SHADOW PICTURE.

On Feb. 6, a plate holder, containing an ordinary sensitive photographic plate and having a slide of hard rubber, 0.025 of an inch thick, was placed eight inches from an arc light. In front of the plate holder were fastened a screwdriver and a leather case containing a pair of eyeglasses. About midway between the arc and the holder a piece of cardboard, .031 of an inch thick, was placed to act as a screen to shield the plate from the intense heat. After an exposure of five hours the plate was developed, giving Fig. 1.

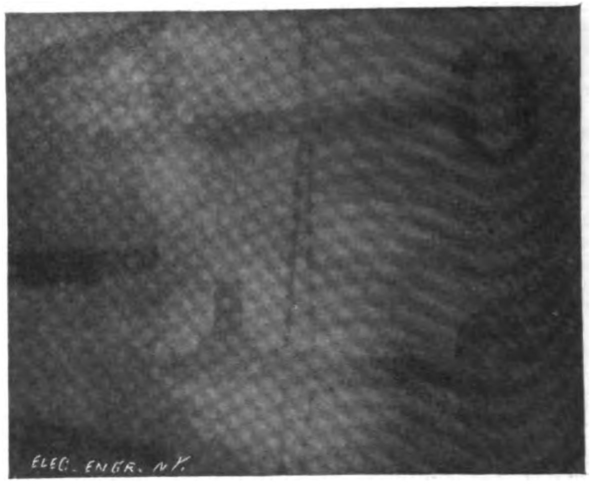


FIG. 2.—A SUNLIGHT SHADOW PICTURE.

This plate of itself is sufficient proof that there are no Röntgen rays emanating from the arc or at least so few that they cannot be detected. For if the impression on the plate were due to Röntgen rays the iron of the screwdriver should show inside of the wooden handle and the eyeglasses should show inside of the leather case.

It was somewhat of a surprise that ordinary light should penetrate cardboard and hard rubber so easily. To satisfy himself the writer determined to expose a plate holder to the

action of the sun, since the spectra of the arc and the sun are very similar.

On Feb. 7, after an exposure of 4½ hours, a fair shadow picture of an ink eraser, penholder and pens was obtained. A second holder on which were fastened two keys (tied with string) and several pens gave, after 6½ hours' exposure, a rather fine plate (Fig. 2). The string casting a heavy shadow again shows the effect to be due to ordinary light.

As additional proofs that these shadow pictures obtained from the arc and the sun are due solely to the filtration of ordinary light, I have the following results of further tests to offer:

1. Glass which casts a heavy shadow to Röntgen rays casts none whatever in any of these instances.
2. When the plate holder used was closed by means of an aluminum slide instead of hard rubber, no shadow picture was obtained. The aluminum slide used was only .01 of an inch thick and is rather transparent to Röntgen rays as proved by many skotographs obtained by Dr. Pupin through slides cut from the same sheet of metal.
3. Plate holders were placed so that the rays of light struck them at an acute angle. In no case was a shadow picture obtained, showing that reflection took place and proving the absence of Röntgen rays.

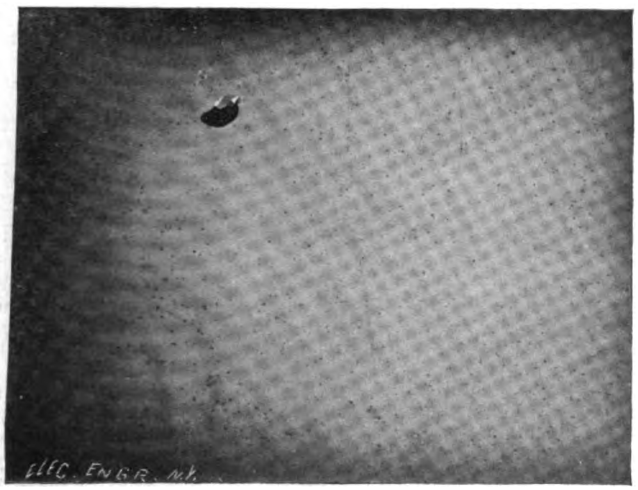
The writer has other results at his disposal, but reserves them till the entire investigation will be completed.

A MAGNET CATHODOGRAPH.

BY E. B. FROST.

AMONG the numerous photographs obtained with the X-rays in the Dartmouth Laboratory, the one illustrated is of perhaps especial interest to electricians. It was secured about February 15 by Mr. F. E. Austin, graduate scholar in physics, under conditions about as follows: A small horseshoe permanent magnet was laid flat upon one end of the plateholder, with its poles pointing toward a small bar magnet placed on the opposite end of the plateholder. Our most efficient tube, No. 1,147, in the catalogue of the maker, Dr. Stöhrer, of Leipzig, was used as the source, being placed horizontally, about 15 cms. above the plate.

A glance at the plate at once suggests that we have here



A SUPPOSED MAGNET CATHODOGRAPH.

magnetic lines of force, depicted without the intervention of iron filings or other substances. But we by no means assert that they are really lines of force. Unfortunately, the exact data of the experiment were not recorded, so that we are not absolutely sure that we have precisely repeated the conditions of the exposure in our subsequent attempts. In no case have we obtained any plate like this one, but we have become rather superstitious that the presence of a magnet near a plate renders it liable to fog. Ordinarily, the magnets exhibit the usual metallic obstruction without any such markings as above. However, if the result depends upon having the magnets separated by a distance which must be accurate within a millimetre and having both at a certain precise distance from the source, then it is not likely that we have yet exactly repeated the conditions of the original experiment. Other plates from the same lot exposed under other conditions, but similarly developed, show no markings, so that it seems difficult to believe that the impression was originally on the plate or arose during development. The spots scattered over the plate are due to holes in the film, but we know of no cause for them.

We have endeavored to account for the appearance of the plate on the assumption of mechanical vibrations of the plate from the neighboring interrupter of the induction coil, but this seems hardly a sufficient cause. The result, however, is entirely objective, and we present it in the hope that it may be confirmed by other experimenters, or that suggestions as to the cause may be given from the experience of others. Meanwhile the experiments of Professor Emerson and myself will be continued with a view to a repetition of the result.

ELECTRIC IMAGES WITHOUT CROOKES TUBES.

BY R. K. DUNCAN.

THE writer has obtained a fine positive impression of a silver dollar on a sensitive plate, showing plainly the head of Liberty and the date by passing a current of 52 volts and 15 amperes into a large induction coil to the terminals of

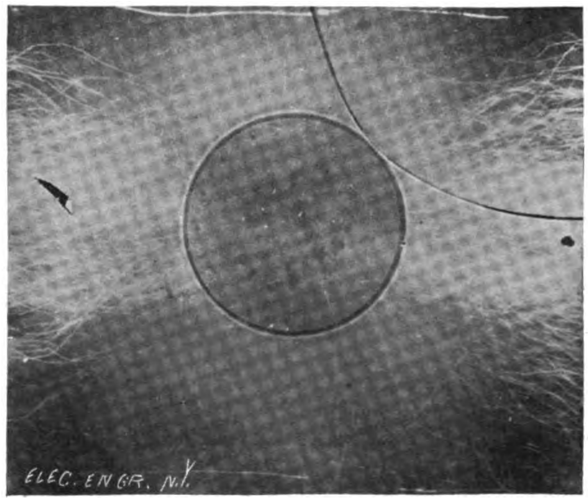


FIG. 1

which were connected two brass plates. The plate holder with the plate and coin in position, both being covered carefully by the ebonite slide, were placed between the two brass plates and the current passed for twenty-five minutes. From each side of the picture of the coin so produced a great brush of fine lines radiates out (Fig. 1). These brushes apear to me to show that the positive of the coin is due simply to electrolytic

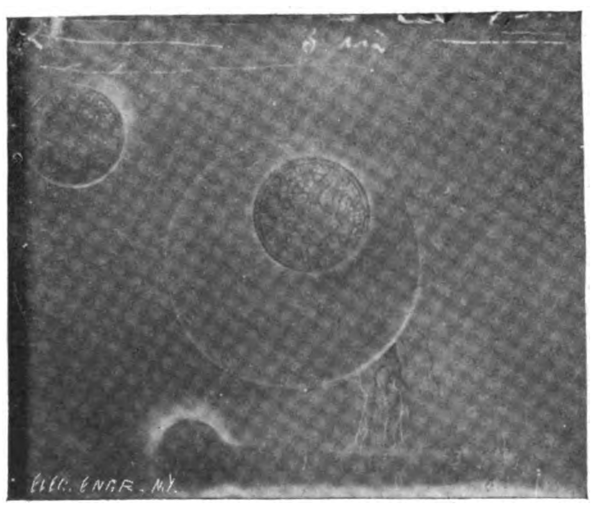


FIG. 2.

action and not to the impact of X-rays, as stated by Morton and others.

Under the impression that the interposition of glass between the terminal and plate holder might interfere with the formation of the image ,the writer then connected one ter-

minal of the induction coil to an ordinary incandescent light bulb with a broken filament and the other to a plate of tinfoil. A silver quarter was placed on the sensitive plate in the plate holder and a watch glass placed carefully over it. Both glass and coin were then covered by the slide and the plate holder was placed on the tinfoil plate. The bulb containing the negative terminal was moved over the surface of the slide. At first the bulb was filled with cathode rays, but a spark soon perforated the glass and destroyed the vacuum. The character of the discharge then resembled that between the two brass plates with the exception that the sparks were now confined to the glass bulb and that the coin was protected by a watch glass. On development there was to be seen not only a very fine picture of the coin, but, curiously enough, a picture of the watch glass in addition. (See Fig. 2.) There is also an absence of the radiating brushes in the brass plates experiment.

ULTRA VIOLET RAYS AND LAMPS ADAPTED TO PRODUCE THEM.

BY HERBERT COTTRELL.

In the year 1852 Professor Stokes communicated to the Royal Society his discovery of what is now called fluorescence. He described the "long spectrum of the electric light," and referred to the "invisible rays outside of the blue end of the spectrum" as being capable of being "rendered visible."

In order to get this invisible light in better condition for testing, he tried the transparency of various substances through which this light would pass, and observed that these rays passed through glass with extreme difficulty. He found, however, that "quartz allowed these invisible rays to pass" with great freedom.

Continuing his observations, he found "in the case of a spark discharge between the poles of an induction coil, that the visible spectrum which was revealed and rendered visible by means of fluorescence, was no less than six or eight times longer than the whole of the (ordinarily) visible part of the spectrum."

Later Professor William Crookes experimented with high potential electric discharges, in tubes exhausted to the highest possible degree, and accomplished what had before been supposed impossible, by showing that such electrical discharge acted across an almost perfectly vacuous space. This electric action rendered the whole interior of such tubes luminous. He discovered also that "these rays proceed in direct lines from the surface of the cathode," and he tried their effect upon many incandescing and phosphorescing substances, obtaining very beautiful luminous effects.

Now Professor Röntgen, employing the discoveries of Professors Stokes and Crookes, shows that he can print the shadow which some of the substances least transparent to the cathode rays cast upon a sensitive photograph plate.

Is this discovery of any practical value? Many think it is, and are most energetic in experimental work on that line. In order to proceed, a proper lamp is the most important requirement. The experience of several years in this branch of electrical work leads the writer to conclude that, whether the line of research is to make shadow prints, or whether it is to produce luminous effects, practically the same condition applies, which is this: that the lamp must be constructed on the principle of an electric condenser; the subjecting to the action of a varying electromagnetic or electrostatic field; of one condenser surface exposed to the vacuum of an exhausted receptacle, and another condenser surface exterior to such receptacle and exposed to air.

An old incandescent lamp (if the state of exhaustion is still of the most perfect character), will do by applying tinfoil to a portion of the outer surface, and then connecting the terminals, from a proper source of electricity, respectively to the filament and the tinfoil. But the best results should not be expected with such a lamp, for one reason, that the filament is not the best form of inner terminal, and also because the incandescent lamp cannot be depended upon to have a sufficiently perfect vacuum for this purpose; besides, the usual form of the incandescent lamp is not well adapted to the application of the foil for use as a reflector.

Those who have facilities to make and exhaust a bulb, will find a spherical one made very thin, to be preferred to the ordinary pear-shaped bulbs. For the inside electrode, carbon in the form of a ball, is good, or, if a metal is preferred, it will be found that aluminum is better that platinum, because platinum disintegrates, by a sort of electrolytic process, and deposits on the interior surface of the bulb and blackens it. A good cement for the carbon electrode consists of 100 grs. carburet of iron, 10 grs. lump sugar, 40 grs. gold bronze. Grind to powder, mix with water to a thick paste, apply and let stand about 20 minutes, then burn to a cherry red in alcohol or gas flame.

Tinfoil is a very good coating for the outside electrode, and may be applied with any suitable adhesive material, or with mercury, as in the mirror-making process.

The exhaustion should be carried to the greatest possible degree. Lamps with "shutters," which are liable to leak, should be constructed so as to be again put on the pump, as they may have to be exhausted repeatedly.

A non-conductive "shutter" should be better than a conductive one, if some material other than aluminum can be used, for securing the difference of potential between the inside and the outside of the bulb.

ON RADIANT MATTER.—IV.

BY WILLIAM CROOKES, F. R. S.

The molecules being driven violently from the pole, there should be a recoil of the pole from the molecules, and by arranging an apparatus so as to have the negative pole movable and the body receiving the impact of the radiant matter fixed, this recoil can be rendered sensible. Fig. 12 represents an apparatus whose appearance is not unlike an ordinary radiometer, with aluminum discs for vanes, each disc coated on one

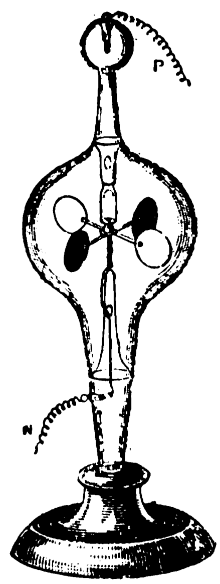


FIG. 12.

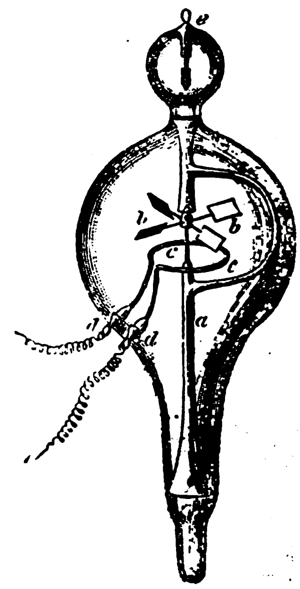


FIG. 13.

side with a film of mica. The fly is supported by a hard steel instead of glass cup, and the needle point on which it works is connected by means of a wire with a platinum terminal sealed into the glass. At the top of the radiometer bulb a second terminal is sealed in. The radiometer therefore can be connected with an induction-coil, the movable fly being made the negative pole.

For these mechanical effects the exhaustion need not be so high as when phosphorescence is produced. The best pressure for this electrical radiometer is a little beyond that at which the dark space round the negative pole extends to the sides of the glass bulb. When the pressure is only a few millims. of mercury, on passing the induction current a halo of velvety violet light forms on the metallic side of the vanes, the mica side remaining dark. As the pressure diminishes, a dark space is seen to separate the violet halo from the metal. At a pressure of half a millim. this dark space extends to the glass, and rotation commences. On continuing the exhaustion the dark space further widens out and appears to flatten itself against the glass when the rotation becomes very rapid.

Fig. 13 represents another piece of apparatus which illustrates the mechanical force of the radiant matter from the negative pole. A stem (a) carries a needle-point in which revolves a light mica fly (b b). The fly consists of four square vanes of thin clear mica, supported on light aluminum arms, and in the center is a small glass cap which rests on the needle-point. The vanes are inclined at an angle of 45 degress to the horizontal plane. Below the fly is a ring of fine platinum wire (c c), the ends of which pass through the glass at d d. An aluminum terminal (e) is sealed in at the top of the tube, and the whole is exhausted to a very high point.

By means of the electric lantern an image of the vanes was

projected on the screen. Wires from the induction-coil were attached, so that the platinum ring was made the negative pole, the aluminum wire (e) being positive. Instantly, owing to the projection of radiant matter from the platinum ring, the vanes rotated with extreme velocity. Thus far the apparatus had shown nothing more than the previous experiments had prepared us to expect; but another phenomenon was then exhibited. The induction-coil was disconnected altogether, and the two ends of the platinum wire connected with a small galvanic battery; this made the ring c c red-hot, and

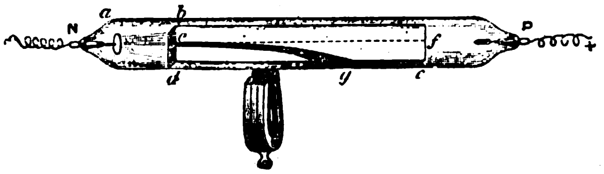


FIG. 14.

under this influence it was seen that the vanes spun as fast as they did when the induction-coil was at work.

Here, then, is another most important fact. Radiant-matter in these high vacua is not only excited by the negative pole of an induction-coil, but a hot wire will set it in motion with force sufficient to drive round the sloping vanes.

We now pass to another property of radiant matter. The long glass tube, shown in Fig. 14, is very highly exhausted; it has a negative pole at one end (a) and a long phosphorescent light (e, f) was projected along the whole length of the tube. A powerful horse-shoe magnet was now placed beneath the tube, and the line of light (e, g) became curved under the magnetic influence, waving about like a flexible wand as the magnet was moved to and fro.

This action of the magnet is very curious, and, if carefully followed up, will elucidate other properties of radiant matter. Fig. 15 represents a tube exactly similar, but having at one end a small potash tube, which, if heated, will slightly injure the vacuum. When the induction current is turned on, the ray of radiant matter is seen tracing its trajectory in a curved line along the screen, under the influence of the horse-shoe magnet beneath. Let us observe the shape of the curve. The molecules shot from the negative pole may be likened to a discharge of iron bullets from a mitrailleuse, and the magnet beneath will represent the earth curving the trajectory of the shot by gravitation. The curved trajectory of the shot is accurately traced on the luminous screen. Now suppose the deflecting force to remain constant, the curve traced by the projectile varies with the velocity. If more powder be put in the gun, the velocity will be greater and the trajectory flatter; and if a denser resisting medium be interposed between the gun and the target,

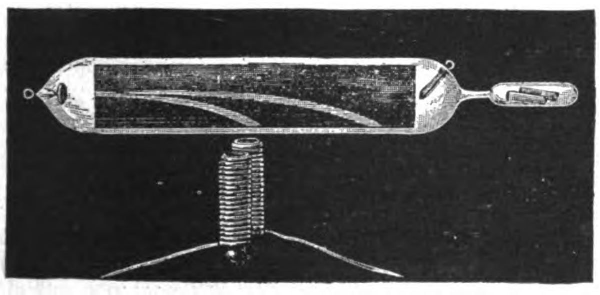


FIG. 15.

the velocity of the shot will be diminished, and it will move in a greater curve and come to the ground sooner. The velocity of this stream of radiant molecules cannot well be increased by strengthening the battery, but they can be made to suffer greater resistance in their flight from one end of the tube to the other. In the experiment shown, the caustic potash was heated with a spirit-lamp, and so a trace more gas was thrown in. Instantly the stream of radiant matter responded. Its velocity was impeded, the magnetism had longer time on which to act to get the molecules, the trajectory became more and more curved, until, instead of shooting nearly to the end of the tube, the "molecular bullets" fell to the bottom before they had got more than half way.

ST. JOSEPH, MO., has had enough of municipal plant lighting, and it is now proposed to sell the plant because it cannot be run on a paying basis.

ELECTRIC TRANSPORTATION.

CAN ELECTRICITY SUPPLANT THE STEAM LOCOMOTIVE ON TRUNK RAILWAYS?—III.

BY

Wm Baxter Jr

As already stated, the saving in coal consumption is not the only way in which electricity can reduce the cost of operating steam roads, nor can the saving in this item alone be expected to amount to anything very formidable, certainly not enough so as to determine the superiority of the system over steam. Nevertheless, the gain in this direction is one of the important factors that will contribute toward making electricity the most economical of the two. It will be well, therefore, to look into this matter and see how much we can reasonably expect the gain in this direction to be. This we can easily do by taking the coal consumption and total operating expenses on several roads, and making the proper deduction therefrom.

From the report of the New York Central Railroad we find that the number of locomotives is 1,197, and if we assume the saving per locomotive per year to be $1,300, as already deduced, the total yearly saving would be $1,556,100, which is about 5 per cent. of the entire operating expenses. If we assume that the saving in coal per unit of energy delivered on the track is 55.6 per cent., as already shown, and take this proportion of the coal bill as the saving, we will then have $1,685,652.87, and this amounts to about 5½ per cent. of the total operating expenses.

Taking the percentage that the coal bill constitutes of the total operating expenses of the roads already considered, and estimating the saving in each on a basis of 55.6 per cent., we obtain the following tabulated results:

Table 2.

Table Showing Percentage of Operating Expenses Saved by Reduced Coal Consumption on the Roads Named.

	Per Cent.
New York Central	5.5
Boston and Albany	5.8
Albany and Susquehanna	10.0
New York, Lake Erie and Western	5.27
New York, New Haven and Hartford	5.0
Boston and Maine	5.5
Pennsylvania Railroad	5.0
Philadelphia and Reading	4.5
Lake Shore and Michigan Southern	5.8
Pittsburg, Cincinnati, Chicago and St. Louis	3.4
Total	55.77
Average	5.57

We see from these figures that the greatest saving in any one case is 10 per cent. of the total expenses of operating the road, while the lowest is 3.4 per cent., the average being about 5½ per cent. It may be claimed by the advocates of steam that these results cannot be realized in practice. Whether they can or not depends upon the accuracy of the assumptions upon which the estimated saving of 55.6 per cent. is based. If the claims that have been made in favor of locomotives were strictly true these results could not be obtained; but these claims are not in accordance with actual facts. The assumption that the coal consumption of locomotives is about sixty pounds per mile only holds good for high speed passenger engines. The report of the Commissioner of Railroads of the State of Ohio for the year 1894 shows that the average coal consumption of all the locomotives in the State was at the rate of 83.48 pounds per mile. The lowest figure given is 46 pounds per train mile, and the highest 256.65 pounds. The report of the State of Illinois gives the figures more in detail, and shows that the coal consumption per train mile is as follows:

Table 3.

Coal Consumption Per Train Mile on Roads in State of Illinois.

	Pounds.
Coal per passenger train mile, average	64.52
Coal per freight train mile, average	104.84
Lowest consumption per passenger train mile	39
Lowest consumption per freight train mile	66.66
Highest consumption per passenger train mile	115.55
Highest consumption per freight train mile	150.76

These figures, together with those given in the report of the State of Ohio, represent the actual performance on about two hundred roads. It will therefore be seen that the claim that has so often been made that locomotives only consume from fifty to sixty pounds of coal per train mile is very far from being true. The average consumption for Ohio is over 83 pounds. The average for the State of Illinois is 84.68 pounds, which is still higher. The estimated saving of electricity over steam by which the results given in Table 2 are obtained, is based on the assumption that the average coal consumption of locomotives is 80 pounds per train mile, and this, it will be seen, is within the actual results obtained in practice.

In so far as the electrical efficiency is concerned, the assumed saving is based on the supposition that the coal consumption in the station would be at the rate of two pounds per hour per horse-power, and that 60 per cent. of the energy of the steam engines could be delivered on the track. Both these assumptions are realized in practice every day.

Table 4.

Passenger Traffic in State of Illinois for 1894.

Miles run by trains	29,235,262
Passengers per train	54
Number of cars	6,915
Number of locomotives	2,083
Average weight of locomotive and tender ...... lb	175,000
Average weight of cars ...... lb	68,000
Average number of cars per train	4
Average weight of train ...... lb	450,000
Average speed of train ...... miles	35
Average coal consumption per train mile ...... lb	64.52
Average coal consumption per hour ...... lb	22.58
Average horse-power required	252
Average coal consumption per hour ...... lb	9
Number cars per locomotive	3.3

I do not pretend to say that the efficiency of locomotives is not as high as it is claimed to be. There can be no doubt about the fact that while in motion the coal consumed per horse power is somewhere in the neighborhood of 3½ or 4 pounds in passenger engines running at a high speed, and perhaps not more than six pounds in heavy freight locomotives, but the total consumption per day, divided by the actual energy developed will show results far below these figures. Every minute that an engine stands still on the track coal is wasted. This does not amount to a serious loss in express passenger engines, because the stops are at long intervals and not of great duration, but in local passenger traffic it amounts to considerable, because of the greater frequency of the stops. In freight trains it assumes a decided importance because it is a very common occurrence for a train to be side-tracked for periods of time ranging from ten or fifteen minutes to an hour or more.

It may be claimed that the fact that the average coal consumption per hour is high is no proof that the efficiency is low, or, in other words, that the pounds per horse-power hour are high; as this large consumption of coal may be interpreted to mean that the average weight of trains is very high and therefore that the energy developed may be enough to bring down the consumption per horse-power hour to a low figure. The only way by which this point could be accurately determined would be by knowing the actual weight and speed of trains. If railroad reports were gotten up with the special view of obtaining such information it would be possible to furnish positive data on the point. But these reports are not made for that purpose; therefore it is only by taking information from several different sources that any data sufficiently reliable to be used as the basis of calculations can be obtained. By such data Tables 4, 5, 6 and 7 have been made out.

Table 5.

Total Movement in State of Illinois for 1894.

Tons carried one mile	6,050,197,710
Miles run by trains	37,801,675
Tons per train	160
Number freight cars	249,537
Number freight locomotives	4,797
Number of cars per locomotive	52
Average weight of locomotive and tender ...... lb	150,000
Average weight of car ...... lb	24,000
Average number of cars per train	20
Average number tons freight per train	160
Average weight of train ...... tons	475
Average speed per hour ...... miles	15
Average coal consumption per hour ...... lb	1,575
Average coal consumption per train mile ...... lb	105
Average horse-power required	151
Average coal consumption per hour ...... lb	10.4

In Table 4 the average number of passengers carried in a train has been obtained by dividing the total number of passengers carried one mile by the number of miles run by the trains. The number of cars, divided by the number of locomotives used in the passenger service, gives the average number of cars for each locomotive. This, as will be seen, is 3.3. The number of cars per train has therefore been assumed to be 4, which is certainly not under the actual number. The weight of cars and locomotives is not given in the reports of the State of Illinois; neither is the speed of trains. This data which is presented in Tables 6, 7 and 8, has been obtained from the report of the New York Central Railroad, the Pennsylvania Railroad, and also through the courtesy of Mr. Theo. N. Ely, Chief of Motive Power of the Pennsylvania Railroad. The speed of trains is the average of the Pennsylvania Road. It must therefore be conceded that the number of cars per train is at least up to the average, while the weight is the average of the maximum weight of cars used on the New York Central Road, and certainly is not below the average weight of all passenger cars in the State of Illinois.

Table 6.

Weight of Cars, Taken from Report of New York Central Railroad. Weight of Freight Cars—Maximum.

	Pounds.
Box	33,000
Stock freight cars	30,000
Coal freight cars	30,000
Flat freight cars	21,000
Caboose, 4 wheels	10,000
Caboose, 8 wheels	30,000
Service cars	18,000
Average maximum weight	24,000
Weight of Passenger Cars—Maximum.	
First-class passenger car	82,000
Second-class passenger car	48,000
Baggage, mail and express cars	75,000

The weight of train, which is taken at 450,000 pounds, is certainly much higher than the average, and so is the speed, but with these figures, we find that the coal consumption per hour is 35 (miles) × 64.52 (lb) = 2,258 lb, and the power required to move the train at 35 miles per hour is:

$$\frac{35 \times 5{,}280 \times 225 \text{ (tons)} \times 12}{60 \times 33{,}000.} = 252 \text{ H. P.}$$

In the above fraction 12 is the number of pounds pull required to draw one ton. Further

$$\frac{2{,}258 \text{ (lbs coal)}}{252 \text{ (H. P.)}} = 9 \text{ lb coal (approx.) per horse power hour.}$$

From this we see that even by making the most liberal calculation in favor of the locomotive, we cannot show that the average performance exceeds an efficiency of 9 pounds per horse-power hour.

Table 7.

Freight Train Data—From Pennsylvania Railroad.

Number of tons carried one mile	6,471,866,950
Number of freight trains	445,052
Number of mixed trains	25,195
Miles run by freight trains	20,400,355
Miles run by switching trains	10,298,317
Miles run by construction and other trains	953,064
Average number of freight cars in a train	30.14
Average number loaded cars in a train	18.84
Average number of empty cars in a train	11.30
Average number of tons of freight in a train	317.25
Average number of tons of freight in each loaded car	16.84
Average speed of freight trains, Pennsylvania Railroad Division, miles per hour	15
New Jersey Division, miles per hour	18
Pennsylvania and Essex Division, miles per hour	12

In respect to the freight traffic, the calculation for determining the coal consumption per horse-power has been made in the same liberal manner, but for all that the amount runs up to 10.4 pounds per hour. By dividing the tons of freight moved one mile by the miles run by trains, as given in Table 3, we find the average number of tons per train is 160. In Table 6 it will be seen that the average number of tons of freight for a train of thirty cars is 317, or at the rate of about ten tons per car.

Now as the average tons of freight train in Table 5 is 160, the average number of cars should be sixteen; but it has been taken at twenty, in the calculation of horse-power, so that the result obtained is certainly better than the actual practical performance, and this is on the assumption that freight trains in Illinois carry as much load on an average as they do on the Pennsylvania Road. This calculation of the power required to move the average freight train is made on the basis of 8 pounds tractive force per ton, which is a liberal figure for a speed of fifteen miles per hour.

These calculations of coal consumption which are based on

Table 8.

Passenger Train Data, Pennsylvania Railroad.

Number of miles run by passenger trains.........	14,908,880
Number of passenger trains......................	389,965
Number of passengers carried one mile	748,872,408
Average number of passengers per train........	100
Speed of Passenger Trains.	
Average speed of ordinary passenger trains, miles per hour, Pennsylvania Railroad Division....	38
New Jersey Division	30
Pennsylvania and Essex Railroad Division......	25
Average speed of ordinary express trains, miles per hour, Pennsylvania Railroad Division...	38
New Jersey Division...........................	40

the actual every-day work of about 100 roads, show that the claim that has so often been made that the margin for improvement in the performance of locomotives is so small that any gain that can be made would not be sufficient to materially reduce the operating expenses of a road, is not sustained by the facts. It is very true that the coal bill does not constitute a very large portion of the total expenditures, but it may safely be taken as amounting to 10 per cent., on an average, of the whole expenses of operating a road.

UNSUCCESSFUL TROLLEY FREIGHT SERVICE IN CALIFORNIA.

One experiment in an electric railroad express business has, it is said, failed. For over a year a street railroad company has been doing about all the express business between Haywards, San Leandro, Oakland, and San Francisco. It commenced by buying out all the smaller companies and by inaugurating a regular electric express service. The loaded wagons were placed on electric cars, and during the quiet portions of the day were attached to the regular passenger cars. The first opposition met with was from the Railroad Commissioners, who claimed that as the road was doing a railroad freight business it came under the same tariff regulations as other railroads. That matter might have been adjusted, but the service has been abandoned because it was not profitable, although the rates charged were only about one-half what the smaller companies had charged. The service was not acceptable to the people, the Secretary of the railroad company explains.

News and Notes.

JACQUES' METHOD OF OBTAINING ELECTRICITY DIRECT FROM CARBON.

THE conversion of the energy of carbon directly into electrical energy, without the medium of the steam engine and dynamo, has long since become the goal for which electricians are striving. The most recent attempt at the solution of this problem is that embodied in a patent just issued to Dr. W. W. Jacques, of Newton, Mass, well known in connection with telephone work.

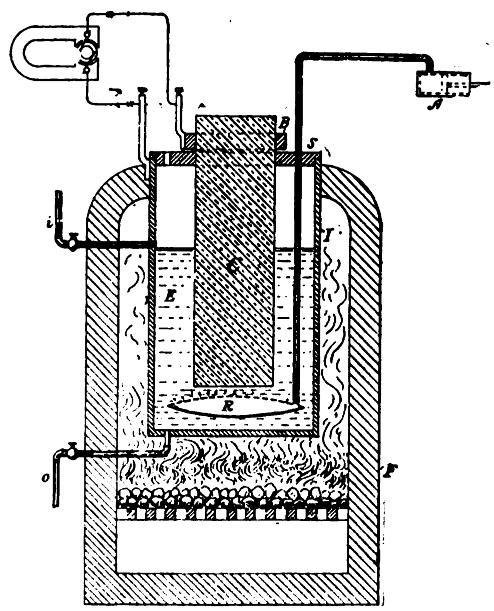
Dr. Jacques has discovered that if oxygen, whether pure or diluted, as in air, be caused to combine with carbon or carbonaceous materials, not directly, as in the case of combustion, but through an intervening electrolyte, the potential energy of the carbon may be converted directly into electrical energy instead of into heat.

A practical way of carrying out this method is to immerse a cylinder of carbon in molten sodium hydrate and to force a current or blast of air into the molten sodium hydrate in such manner that it becomes impregnated with oxygen in excess over that which sodium hydrate normally contains. A circuit being completed from the sodium hydrate, which is the electrolyte, by means of a collecting-electrode not chemically acted upon by the electrolyte and an extraneous conductor to the carbon, an electric current flows continuously from the sodium hydrate through the collecting-electrode and the exterior conductor to the carbon, the strength of the current depending primarily upon the rapidity with which the air is blown into the sodium hydrate, and the oxygen of the air caused to combine with the carbon.

The arrangement for carrying out the process is shown in the accompanying illustration. The carbon C, is immersed in the caustic soda solution E. A pump A, forces air into the rose R, which distributes it evenly into the electrolyte. The solution is contained in the Norway iron pot I, which forms the positive terminal, the negative B being clamped to the carbon C, which is supported by the insulating cover S. The caustic soda solution is admitted and removed by the pipes i and o. The whole is surrounded by a furnace F, which maintains the active cell at a temperature of 400 to 500 degrees Centigrade.

In this process the carbon is gradually converted into carbonic acid, which mostly bubbles up through the electrolyte and escapes. The resultant composition of the sodium hydrate remains unchanged, except as shown below, and oxygen of the air is consumed. The nitrogen with which the oxygen of the air is diluted, having no chemical affinity for any other substance present, simply bubbles through the electrolyte and escapes.

Dr. Jacques' conception of the function of the electrolyte is that it carries oxygen electrolytically from the air to the carbon, or that the phenomenon of electrolytic action causes the



JACQUES' CARBON CONSUMING ELECTRIC GENERATOR.

conversion of the potential energy of the carbon into electrical energy instead of into heat, as is the case when oxygen combines with carbon without the intervention of an electrolyte.

Although the greater part of the carbonic acid, whether resulting from the union of carbon and oxygen already existing in the air supply, bubbles up through the electrolyte and escapes, a portion of the carbonic acid combines with a portion of the caustic soda to form carbonate of soda, and this, together with the ash from the carbon, slowly contaminates the electrolyte, and in the course of time lessens its efficiency. The efficiency may be maintained by drawing off from time to time a portion of the contaminated electrolyte and admitting a fresh portion to take its place.

The contamination of the caustic soda by its union with carbonic acid may be reduced, and its life prolonged, by adding a small percentage of oxide of magnesium. According to Dr. Jacques, the action of the oxide of magnesium is that the free carbonic acid combines with it in preference to the caustic soda, and that the carbonate of magnesium so formed is quickly decomposed into carbonic acid, which escapes, and oxide of magnesium which is again ready to repeat its action. Briefly, the oxide of magnesium serves as a carrier to convey the carbonic acid through the electrolyte.

The current obtainable by this type of generator is said to be very large, but the voltage, which is not given by Dr. Jacques, is low.

"THE ENGINEERING MAGAZINE" for March contains a Röntgen article by Dr. Pupin and an article on "Lighting Residences by Electricity," from the pen of Mr. Augustus Noll.

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CONTENTS.

STANDARDIZING THE RULES FOR CONSTRUCTION AND OPERATION.

THE fact that next week will witness the gathering in this city of a number of representative men for a conference on the subject of standardizing the rules which govern electrical construction and operation and which lie at the basis of electrical insurance, prompts us to the expression of a fervent hope that the occasion will realize all that the organizers of the conference propose. This subject of unification has already been several times advocated in these pages, and it is encouraging to find that so definite an approach to common and harmonious action is now likely of success.

The names of the various bodies and leading corporations that are to confer have been given to the public, and this week is added a list of delegates invited to attend in an advisory capacity, as representative of the general interests of the electrical profession. We note also that an invitation has been issued also to the Underwriters' National Electric Association to co-operate. While that body is closely identified with the National Board of Fire Underwriters, its important work in the preparation and enforcement of good rules gives it the right to a place of its own in these counsels.

It is understood that the conference will not attempt legislation, but we shall be greatly disappointed if, with the excellent codes before it, the various growth of the experience of past years, it cannot produce a standard national set of rules which every organization that has been represented in its preparation will be glad to approve and sanction. The time is rife for such a codification. The gain to the electrical arts will be immense. The saving to the insurance interests will be incalculable. A set of rules everywhere known to have behind it the weight of general sanction will carry with it an official authority that no single set and no individual practice could ever secure. At the present moment there is confusion and conflict, but it is wholly unnecessary, and should be succeeded by a peace due to scientific legislation. We venture to ask for the conference the cordial support and active interest of all who desire to see electricity outrank other agencies as the safest and best, whether for life or for property, in the distribution of light, heat, power, intelligence, and other requirements of modern civilization.

STREET RAILWAY LEGISLATION.

THERE was a flocking of street railway magnates to Albany last week to argue against a number of new bills presented chiefly as the result of the report of the Nixon investigation committee. Among these measures may be mentioned bills compelling railroad companies to properly light and heat their cars; compelling 5-cent fares and transfer tickets by companies within cities; providing for the sale to the highest bidder of street railway franchises; providing that railroads be capitalized at $6,000 for each mile of road; compelling one car to stop before passing another which is at a standstill unloading passengers upon any street; compelling railroads to adopt fenders. Now, some of the bills have merit; others attempt to impose conditions governed by the local traffic and topography, and all of them taken together would easily throw an eminently solvent road into bankruptcy. Even the limitation of capital per mile has its defects. We know of one road in a minor city, where the special work within a single mile of track required a total expenditure of about $80,000 for just that stretch.

We cannot help thinking that the recent opinion expressed on many of these points by the City Solicitor of Philadelphia to the councils has the stamp of common sense on it. He said that many things complained of could be better regulated by mutual understanding than by the exercise of the power vested in the city government. The matter of heating cars, for instance, should be determined by the corporation and the public demand, inasmuch as there might be wide differences of opinion as to the best way of doing it. To require companies

also to provide a seat for each passenger would not be practicable, in his opinion, as to make this imperative would involve the corresponding duty on the part of the company to exclude a passenger from a car when all the seats are occupied, and this the public would probably object to as a great inconvenience.

ELECTRICITY DIRECT FROM COAL.

WRITERS of magazine articles, in discussing the problems in science still to be solved, never fail to refer, among other things, to the obvious desirability of obtaining light without heat and electricity direct from coal. The former of these two desiderata has of late years been actively worked at, and the results obtained are eminently encouraging, but there seems to be something repellant about the electricity-direct-from-coal problem, judging at least by the small number of experimenters who have attacked it, and the paucity of the results thus far obtained. Whether the thermopile or the electro-chemical battery will bring us to the desired end is still an open question. We have recently described what to all appearances is a marked advance in thermo-battery work—that of Mr. H. B. Cox; and this week we describe a departure in another direction due to Dr. W. W. Jacques. The salient features of Dr. Jacques' invention, and those which in our estimation give it more promise of success than its predecessors in this field, is the fact that he employs the unlimited store of atmospheric oxygen as his active agent. Others—for example, Jablochkoff, who used fused nitre, and Case, who employed chlorate of potash, depended upon the materials of the battery to furnish the required oxygen, but it will be apparent that a method by which expensive materials, rich in oxygen, are avoided, possesses advantages of prime importance, viewed from the commercial standpoint. Thus far no definite data as to the voltage or efficiency of the Jacques cell have been forthcoming, but even if the voltage is low, as is to be expected from the combination of metals employed, this need not necessarily debar the battery from many useful and perhaps extended applications, especially in connection with storage batteries, which can be charged in parallel and discharged in series for distribution.

ELECTRICAL CORPORATIONS IN MASSACHUSETTS.

SPEAKING last week in Boston before the Electric Potentials, Mr. E. W. Burdett, who has long made a special study of the subject, discussed in an able manner the legal status of electrical corporations in the State of Massachusetts. As a matter of fact, his remarks covered all corporations using the streets, though he classed the street railways by themselves and grouped all the rest together. It will be remembered that the feature of commissions plays a large part in the regulation of railway, gas, and electric lighting corporations in the State, and that these, especially since the legislation of 1894, are largely subject to government by commission. This tendency is certainly a growing one and deserves to be watched. Mr. Burdett took occasion, for instance, to point out that the Lighting Commission had far larger powers than the Railway, and it seems to us that whether in Massachusetts or elsewhere, each new commission is likely to seek or to get larger powers, until the Legislature becomes jealous of the bodies that practically exercise its delegated powers.

As we noted last week, the results in New England have been on the whole beneficial to corporations run on proper lines; and at the club meeting Commissioner Barker could rightly claim, as Mr. Burdett had willingly admitted, that his own board had met with considerable success in its work of mediation, protection and real stimulus to the industry. Most striking of all is his statement to the effect that there is a prospect of legislation by which, when a public service corporation, through no fault of its own, sustains great and extraordinary losses, it shall have the right to make that up in some proper, safe and reasonable way. This is something novel, but its intrinsic justice commends it, and it gives evidence of a kindlier feeling in the State towards progressive corporations than has hitherto prevailed.

TRADE CREDITS.

NO small credit is due to the quiet, earnest business men of Philadelphia, who came over to New York last week, and by the logic of facts convinced their fellow manufacturers and dealers in this city that it would be a good thing to stand together in the repression of the dishonest debtor. It is a wonder that something of the kind has not, indeed, been tried before. The electrical trades have grown rapidly and ramified widely. It has been easy for unscrupulous men to trap even the shrewdest seller, by shifting their accounts from one firm to another, or from one city to another, and the evil of a loose credit system has grown alarmingly. The latter days of commercial stress and trial have developed very plainly the necessity of joint dealing with the state of affairs that has arisen, and now the example of the plumbers, the booksellers and other trades will be followed, with more or less modification. The plan which the electrical leaders in the trade of Philadelphia declare to have worked well can be equally efficacious in Boston, New York and Chicago, and there should be unanimity of effort.

Quite aside from the commercial aspect of this matter, we see in it a promise of better things, as regarded from the engineering standpoint. The movement is not directed against the honest trader, nor against the competent contractor and skillful engineer. It operates rather for their protection. It makes alike for better prices and for better work. There will not be so much poor material used, and there will not be so much chance for incompetency, when the industry as a whole insists on probity in business transactions. Under the best system of prevention, the person who means to be dishonest will succeed in imposing on his creditors; but he is now apt to find his opportunities greatly limited, and everybody else will be the gainer.

ROENTGEN RAYS.

WE give space in this issue to a number of contributions relating to the theory and application of the Röntgen rays. Professor Thomson, it will be noted, makes the very ingenious suggestion of viewing the Röntgen ray pictures stereoscopically and the idea will without doubt be acted upon. From the experiments detailed by Professor Stine and Mr. Freedman, it must now be conceded that the shadow photographs obtained by means of the arc and sunlight are not X-ray pictures, or, at least, that if X-rays are present in either of these sources of illumination, they are too weak to make their presence apparent in any pictures thus far obtained.

THE VAN DEPOELE UNDERRUNNING TROLLEY PATENT.

ONE of the most far-reaching decisions was that of Judge Townsend, upholding the Van Depoele under-running trolley patent, already rendered, but a few months ago. The General Electric Company has evidently determined to test the value of this patent on all points, for, having first obtained an injunction against an operating railway, it has followed up this victory by securing another, albeit preliminary, injunction against a manufacturer of parts of the trolley gear. The decision just rendered by Judge Townsend goes so far even as to practically interdict the supply even of repair parts by outside manufacturers to railway companies originally equipped by the General Electric Company. The decision is in line with that rendered in the case involving the repair of incandescent lamps by the inserting of new filaments into the bulbs and re-exhausting them. This practice, it will be recalled, was also held to be an infringement. The cases will probably be fought out to the bitter end by both parties, and in the mean time rumors are rife of the adoption of thoroughly feasible methods and contrivances for circumventing the Van Depoele patent.

MECHANICAL.

COMPARATIVE TESTS OF SMOKE PREVENTING FURNACES.

BY B. R. T. COLLINS, ENGINEER OF TESTS, CHICAGO EDISON CO.

THE Chicago Edison Co. has in its Harrison street station two types of smoke-preventing furnaces, viz., the Hawley "down draft" furnace and the McKenzie furnace. To

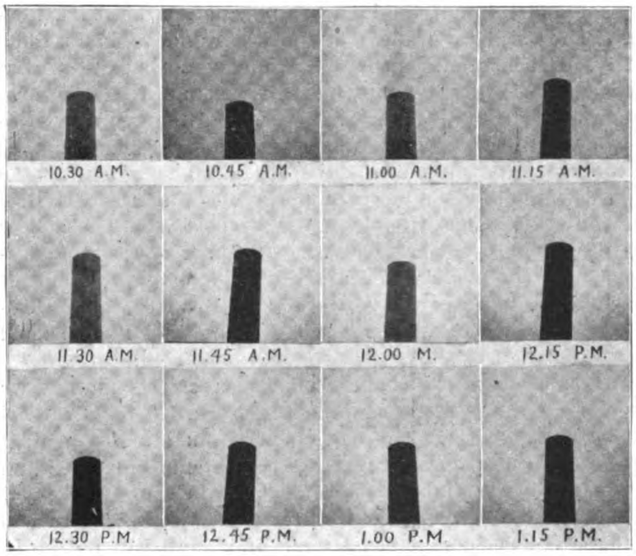


FIG. 1.—SMOKE RECORD FOR CAPACITY TEST ON MCKENZIE FURNACE, 10.30 A.M. TO 1.15 P.M. FEB. 15, 1896.

ascertain the relative efficiency of these furnaces in regard to smoke prevention, as well as their economic evaporation at varying capacities, and also the limitations of capacity under equal conditions, a series of tests were made with careful attention to details and every precaution to secure accuracy of results.

These tests were undertaken by the Edison Company for the

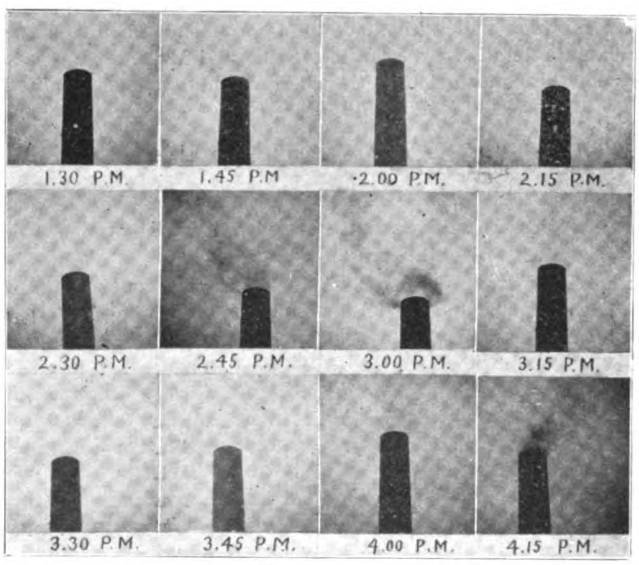


FIG. 2.—SMOKE RECORD FOR CAPACITY TEST ON MCKENZIE FURNACE, 1.30 P.M. TO 4.15 P.M. FEB. 15, 1896.

sole purpose of determining, for its own information, the relative performance of the two furnaces, but both furnace companies interested were notified that the tests were to be made and that they could have representatives present if they so desired, and such were present from both companies on all the tests. At the request of both furnace companies, made before the tests, the results are given to the public, in order to avoid incorrect statements concerning them. The conditions, methods and results are given without drawing any conclusions, leaving that to be done by those interested after all the facts have been placed before them.

Before describing the tests it might be well to mention, by way of introduction, that the Hawley furnace operates on the well-known downward draft principle in which the smoke and gases are forced to pass downward through the fire bed, formed on a water tube grate, which is necessary on account of the intense heat generated, and the carbon and gases are thus brought into a favorable condition for complete combustion, a

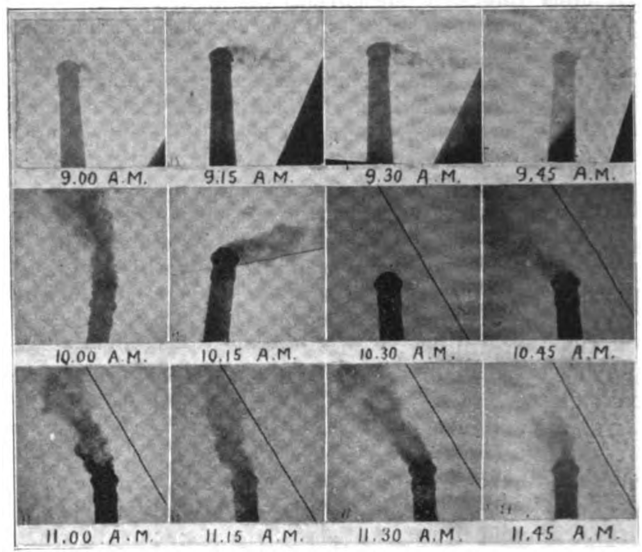


FIG. 3.—SMOKE RECORD FOR CAPACITY TEST ON HAWLEY FURNACE, 9.00 A.M. TO 11.45 A.M. FEB. 16, 1896.

lower grate being provided to receive the incandescent fuel as it falls from the upper grate. On the other hand, the McKenzie furnace operates on the entirely different principle of fire-brick columns placed beyond the bridge wall, which cause a thorough mingling of the smoke and gases and at the same time increases the heat of this mixture. Heated air is also supplied through numerous openings near the top of the bridge wall and in the sides of the above mentioned columns which

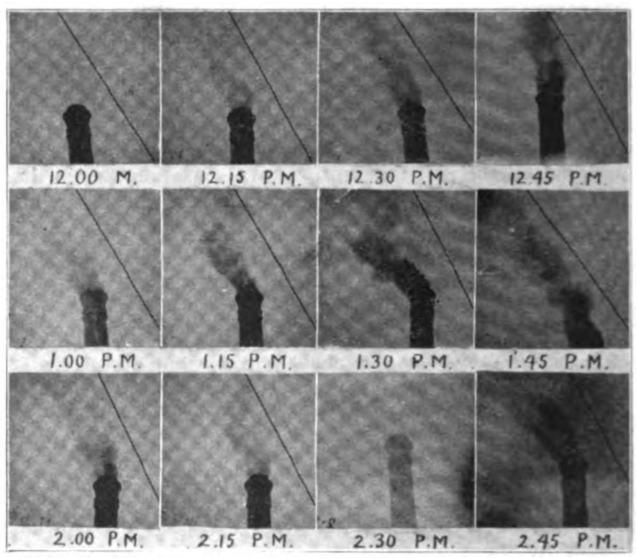


FIG. 4.—SMOKE RECORD FOR CAPACITY TEST ON HAWLEY FURNACE, 12.00 M. TO 2.45 P. M. FEB. 16, 1896.

are hollow, thus favoring more complete combustion. In addition to these there are air syphons placed in front, above the fire doors, to supply air and effect a thorough mingling of the air, gases and carbon, thus aiding combustion. These, briefly, are the principles involved in the furnaces tested.

The Hawley furnace tests were made on boiler No. 1, which

is a Heine safety boiler, rated at 500 horse-power capacity on the Heine basis, which is obtained by dividing the equivalent evaporation from and at 212 degrees Fahrenheit by 31 lbs. This basis, however, has no foundation in reason, as the commercial horse-power of a boiler is obtained by dividing the equivalent evaporation from and at 212 degrees Fahrenheit by 34.5 lbs., which is used by all other boiler-makers except the Heine Company; but as the boilers are rated on this 31-lb basis, this has been used in determining the horse-power developed in the results given below. Boiler No. 1 has two 42-inch shells, 19 feet 9½ inches long, 241 3½-inch tubes, 16 feet long, 3,800 square feet heating surface and 65 square feet upper water tube grate surface.

The McKenzie furnace tests were made on boiler No. 8, which is a Heine safety boiler of the same dimensions as No. 1, except that it is two rows of tubes higher (37 tubes), making 278 3½-inch tubes with a heating surface of 4,340 square feet, which, at the same rating (7.6 square feet per horse-power) would be a capacity of 571 horse-power, but this is hardly fair to the boiler, as the additional tubes probably have only 50 per cent. of the efficiency of the average tube. However, with this explanation it will be taken at 571 horse-power capacity.

In this connection it should be remembered that the water tube grates of the Hawley furnace add to the heating surface of the boiler, but are not considered as increasing its rated capacity.

The stack to which No. 1 is connected is 185 feet high above the grate bars, giving about 1 inch of draught, whereas the stack for No. 8 is only 102 feet 8 inches high, giving but ½ inch to 9-16 inch draught; consequently to make the conditions equal, so as to admit of comparison, the damper at the base of the tall stack was lowered until the same draught was obtained in the breeching over No. 1 boiler as existed in the breeching over No. 8 boiler, and these conditions were maintained during the respective comparative tests.

Following are some of the details of the methods used in making the tests: The fires were cleaned half an hour before the beginning and end of each test and at equal intervals during the test as was found necessary. The boilers were run at about the same rate as during the test for several hours previous to starting the test and were thus thoroughly heated. The coal was weighed by the barrowful, in lots large enough for about one hour's firing. The ash chutes were cleaned out on starting and stopping the test, and ashes accumulating during the time of the test carefully weighed. The conditions as to kind of fire, amount of coal on the grates, height of water level and gauge pressure were noted at the beginning of each test and obtained as nearly as possible at the close, the water level and gauge pressure being maintained as constant as possible throughout the test. The water used for these tests was taken from the hot well and weighed by means of two tanks on scales of an average capacity of about 900 lbs., these tanks discharging into a reservoir from which the test feed pump took its supply and discharged it through an independent feed line to the boiler being tested. All of the valves leading off of this line were tightly closed and sealed with wax and examined after the tests, all being found intact. All of the scales used for weighing coal, ashes, and water were tested and adjusted to read correctly. The temperature of the escaping gases was taken in the uptakes just below the dampers by a thermometer reading to 800 degrees Fahr. The draught was taken by a draught-gauge connected to a pipe extending about 3 feet into the breeching above the boiler. The atmospheric pressure was taken from an aneroid barometer, compared and corrected by a mercurial barometer.

The moisture in the steam was found to be very small on boiler No. 1, but on account of difficulty in making a proper connection on boiler No. 8, it was neglected in the results on both boilers. The calorimeter used was of the throttling type designed by the writer and used on a large variety of tests with uniformly satisfactory results.

Each boiler was thoroughly washed and put in the best possible condition just previous to the tests, the flues being blown two hours previous to the start of the test in each case. The steam gauge used was tested and corrected, and transferred from one boiler to the other for each test. The blow-off pipes were plugged in each case and in the case of boiler No. 1, where the connections were not tight, the drip was collected and weighed back.

The coal used on all the tests was Auburn screenings from the Sugar Creek Mining Company's mines, which are situated about fifteen miles south of Springfield, Ill., or 200 miles south of Chicago. The tests of Feb. 2 and 3 were made with coal from the same car to insure uniform quality as far as possible, as were also the tests of Feb. 15 and 16. The firing on the Hawley test of Feb. 2 was done by the expert fireman of the Hawley Company, and that on the McKenzie test of Feb. 3 by one of the regular head firemen of the station. On the capacity test of the Hawley furnace the firing was done by two expert firemen of the Hawley Company, and on the capacity test of the McKenzie furnace, by a regular head fireman of the station and an assistant.

In weighing water and coal, regulating the water level, taking all of the observations and keeping all of the records necessary on tests of this kind I was assisted by a trained corps of six assistants, who have performed similar duties in connection with the large number of tests of various kinds which have been made at Harrison street station during the past two years, thus insuring in a large degree the accuracy of the results obtained.

The smoke record was kept by means of instantaneous photographs taken at fifteen-minute intervals throughout each test by the official photographer of the Edison Company. The records of the capacity tests of Feb. 15 and 16 are reproduced in full, while the record of the economy tests of Feb. 2 and 3 is omitted, as it shows only very small amounts of smoke. It should be stated here that boiler No. 1, used on the Hawley furnace tests, was equipped with three fire-brick arches four feet long at the bridge wall through which all the gases had to pass. These were put in by the Hawley Company as an additional device for smoke prevention when the fires were

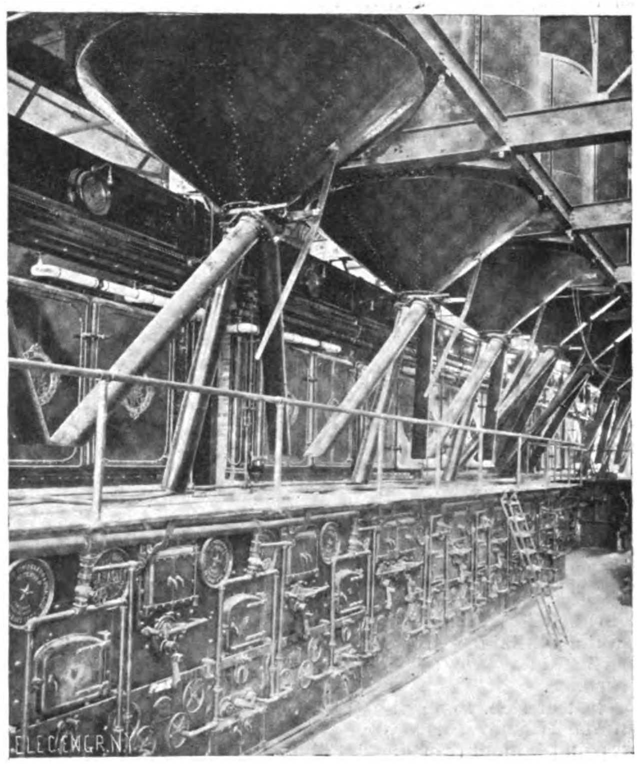


Fig. 5.—Boiler Room, Chicago Edison Co.

being forced. The boiler being tested, was the only boiler using the stack at the time of the tests, in order to obtain a record of the smoke from one boiler only.

The tests of Feb. 2 on the Hawley furnace and of Feb. 3 on the McKenzie furnace were made for most economic evaporation, the basis of comparison being equal amounts of coal burned per square feet of grate surface with equal draught. The coal burned was limited to 31 lbs. per square foot of grate surface, as this had been found to give the best results on the Hawley furnace, judging from a series of 25 or 30 tests made on that furnace at the station during the past year with different kinds of screenings. The results in detail are as given in Table 1.

From this table it will be seen that the Hawley furnace shows .19 lb greater actual evaporation, or 3.16 per cent.; .26 lb greater evaporation from and at 212 degrees Fahr., or 3.71 per cent.; 10 horse-power less capacity, but on account of difference in rating, 10 per cent. greater proportion of capacity developed; 2.1 per cent. greater efficiency; 40.4 degrees Fahr., or 5.85 per cent. lower flue temperature; 3.9 per cent. greater proportion of ash, and \$0.002, or 2.82 per cent. less to evaporate 1,000 lbs. of water than the McKenzie furnace.

The amount of steam used in the air syphons of the McKen-

zie furnace was determined by condensing the steam issuing from the steam orifices under the same conditions as during the tests and obtaining its actual weight. The mean of three experiments gave 315 lbs. of steam per hour, or 2.16 per cent. of the evaporation of the boiler from and at 212 degrees Fahr. Taking this into consideration the water evaporated per lb. of coal from and at 212 degrees Fahr. would be reduced from 7

TABLE 1.

COMPARATIVE TESTS FOR ECONOMIC EVAPORATION.

	Hawley.	McKenzie.
Date of trial	Feb. 2, 1896	Feb. 3, 1896
Duration of trial ... hours	8	8
Dimensions and Proportions:		
Number and diameter of tubes	241-3½" × 16'	278-3½" × 16'
Grate surface ... area, sq. ft.	65	68.6
Water heating surface ... sq. ft.	3,800	4,430
Ratio of grate surface to heating surface	1 to 58.5	1 to 63.3
Chimney dimensions, height and diameter	185' × 13'	102'-8" × 8'-10"
Force of draught ... inches of water	0.5	0.5
Average Pressures:		
Steam in boiler, by gauge ... lb	169.6	171.8
Atmosphere, by barometer ... lb	14.3	14.1
Absolute pressure ... lb	183.9	185.9
Average Temperatures:		
Of feed water entering boiler ... deg. F.	95.0	100.4
Of flue gases at uptake ... deg. F.	649.6	690.0
Fuel—Kind of Coal—Auburn Screenings:		
Cost per ton of 2,000 lb, delivered	$1.00	$1.00
Calorific power by analysis—B. T. U. per lb	11,912	11,912
Theoretic evaporative power, from and at 212° F., in lbs. water, per lb coal	12.33	12.33
Total quantity consumed ... lb	16,065	17,027
Total ash, clinkers and unburned coal ... lb	2,426	1,907
Proportion of ash, etc., to coal ... per cent.	15.1	11.2
Combustion Per Hour:		
Coal actually consumed ... lb	2,008	2,128
Coal per sq. ft. grate surface ... lb	30.9	31.0
Coal per sq. ft. heating surface ... lb	.528	.490
Water:		
Amount apparently evaporated ... lb	99,514	102,024
Factor of evaporation	1.173	1.168
Equivalent evaporation from and at 212° F.	116,730	119,164
Economic Evaporation—Per Pound of Coal:		
Water actually evaporated ... lb	6.19	6.00
Equivalent from and at 212° F. ... lb	7.26	7.00
Evaporation Per Hour:		
Water actually evaporated ... lb	12,439	12,753
Equivalent from and at 212° F. ... lb	14,591	14,895
Per sq. ft. heat. surf.—actually evap. ... lb	3.27	2.94
Equivalent from and at 212° F. ... lb	3.84	3.43
Per sq. ft. grate surf.—actually evap. ... lb	191.4	185.9
Equivalent from and at 212° F. ... lb	224.5	217.1
Efficiency:		
Per cent. of total calorific power utilized	58.9	56.8
Water evap. for $1 worth of fuel ... lb	14,520	14,000
Cost of evaporating 1,000 lb of water	$0.069	$0.071
Coal consumed per H. P. per hour ... lb	4.26	4.42
Cost of same	$0.0021	$0.0022
Horsepower:		
Actually developed on Heine basis of 31 lb water evap. per hour from and at 212° F.	471	481
Heine rating ... horsepower	500	571
Proportion capacity develop'd, rating ... %	94.2	84.2
Heating surface to develop I.H.P. ... sq. ft.	8.07	9.02

lbs. to 6.85 lbs, available outside of the boiler, which would make the available evaporation from and at 212 degrees Fahr., shown by these two tests, 5.99 per cent in favor of the Hawley furnace.

The test of Feb. 15 on the McKenzie furnace and that of Feb. 16 on the Hawley furnace were made for maximum capacity with equal amount of draught; the amount of coal to be burned being unlimited in order to determine the maximum amount of this particular coal that could be burned by each furnace under equal conditions.

The tests for economic evaporation were eight hours in duration, but it was considered that six hours of forced firing would be long enough to obtain a fair average, hence the tests for capacity were six hours long. On Feb. 15, after running a little over an hour an attempt to clean the fires was made, when it was found that, owing to the peculiar condition of the fire, the grate bars were completely covered with a hard metallic clinker which required half an hour to remove, and during this time evaporation was almost completely checked, hence for the sake of fairness, the test was recommenced at the beginning of the next hour and continued for six hours thereafter.

On the test of Feb. 16 the coal, which was taken from the same car as that used on the 15th, was exhausted and hence two barrows of coal from another car had to be taken to finish out the test. The results of the capacity tests are given in Table 2.

From the results in Table 2 it will be seen that the McKenzie furnace shows .74 lb., or 14.0 per cent greater actual evaporation; .18 lb., or 13.4 per cent. greater evaporation from and at 212 degrees Fahr.; 23.4 horse-power greater capacity, but on account of difference in rating 8.6 per cent. less proportion of capacity developed; 7.3 per cent. greater efficiency; 52.9 degrees Fahr., or 8.12 per cent. higher flue temperature; 1 per cent. great proportion of ash, and $0.01, or 12.3 per cent. less to evaporate 1,000 lbs. of water than the Hawley furnace. Taking into consideration the steam used in the air syphons, which was 2.16 per cent., as stated above, the available evaporation for use outside of the boiler would be 6.87 from and at 212 degrees Fahr., which would make the available evaporation

TABLE 2.

COMPARATIVE TESTS FOR MAXIMUM CAPACITY.

	McKenzie.	Hawley.
Date of trial	Feb. 15, 1896.	Feb. 16, 1896.
Duration of trial ... hours	6	6
Dimensions and Proportions:		
Number and diameter of tubes	278 3½" x 16'	241 3½" x 16'
Grate surface ... area, sq. ft.	68.6	65
Water heating surface ... sq. ft.	4,340	3,800
Ratio of grate surface to heating surface	1 to 63.3	1 to 58.5
Chimney dimensions, height and diameter	102'-8" x 8'-10"	185' x 13'
Force of draught ... inches of water	9/16	9/16
Average Pressures:		
Steam in boiler, by gauge ... lbs.	170.8	175.7
Atmosphere, by barometer ... lbs.	14.2	14.2
Absolute pressure ... lbs.	185.0	189.9
Average temperatures:		
Of feed water entering boiler ... deg. F.	99.9	95.2
Of flue gases at uptake ... deg. F.	704.2	651.3
Fuel—Kind of Coal, Auburn screenings:		
Cost per ton of 2,000 lbs., delivered	$1.00	$1.00
Calorific power by analysis, B. T. U. ... per lb.	11,912	11,912
Theoretic evaporative power, from and at 212° F., in lbs., water per lb. coal	12.33	12.33
Total quantity consumed ... lbs.	14,321	15,299
Total ash, clinkers and unburned coal ... lbs.	1,954	1,920
Proportion of ash, etc., to coal ... per cent.	13.6	12.6
Combustion per Hour:		
Coal actually consumed ... lbs.	2,350	2,550
Coal per sq. ft. grate surface ... lbs.	34.26	39.23
Coal per sq. ft. heating surface ... lbs.	.550	.671
Water:		
Amount apparently evaporated ... lbs.	84,741	80,620
Factor of evaporation	1.1684	1.174
Equivalent evaporation from and at 212° F.	99,011	94,684
Economic Evaporation, per Pound of Coal:		
Water actually evaporated ... lbs.	6.01	5.27
Equivalent from and at 212° F. ... lbs.	7.02	6.19
Evaporation Per Hour:		
Water actually evaporated ... lbs.	14,124	13,437
Equivalent from and at 212° F. ... lbs.	16,502	15,775
Per sq. ft. heating surf., actually evaporated, lbs.	3.25	3.53
Equivalent from and at 212° F. ... lbs.	3.80	4.15
Per sq. ft. grate surface, actually evaporated, lbs.	205.9	206.7
Equivalent from and at 212° F. ... lbs.	240.6	242.7
Efficiency:		
Percentage of total calorific power utilized	56.9	49.6
Water evaporated for $1.00 worth of fuel ... lbs.	14,040	12,380
Cost of evaporating 1,000 lbs. of water	$0.071	$0.081
Coal consumed per horse power per hour ... lbs.	4.41	5.01
Cost of same	$0.0022	$0.0025
Horse Power:		
Actually developed on Heine basis of 31 lbs. water evaporated per hour from and at 212° F.	532.3	508.9
Heine rating ... horse power	571	500
Proportion capacity developed is of rating ... p. ct.	93.2	101.8
Heating surface to develop 1 horse power ... sq. ft.	8.15	7.47

from and at 212 degrees Fahr., 10.99 per cent. in favor of the McKenzie furnace.

These tests also show that 39.23 lbs. is the maximum amount of this particular coal that can be burned by the Hawley furnace, with 9-16 inch draught, per square foot of grate surface per hour. Under the same conditions the maximum limit of the McKenzie furnace is 34.26 lbs., which is 4.97 lbs., or 14.5 per cent. less than the Hawley furnace, but the double grate of the latter should be taken into consideration in this connection.

A POWER PLANT IN MARIPOSA COUNTY, CAL.

Mariposa County, California, is to have one of the largest electrical power developing and distributing plants in the United States. It will be at the Horseshoe Bend, on the Merced River. The location is near the center of a mining district, having at least 100 mines that are sufficiently prospected to use cheap power. At the driest season of the year the power company calculates upon 1,800 horse-power, and during eight months in the year they expect water enough to generate 3,500 horse-power. The price the company proposes to charge its customers is $5 per horse-power a month. At the present time the expense of producing steam is from $12 to $15 per horse-power, and two years hence, at the present rate of consumption of cordwood, the hills would be bare of timber, and steam power, except in a few localities, at a price almost prohibitive.

THE ELECTRIC light installation in the handsome building of the Duquesne Club, Pittsburg, will be a complete one in every respect. "Ball" engines, built by the Ball Engine Company, Erie, Pa., direct connected to Westinghouse dynamos, furnish the light and power.

STRATTON COMBINED SEPARATOR AND STEAM RECEIVER.

THE fall of pressure that takes place between the boiler and the engine, due to the fact that the volume of steam necessary for one stroke of the engine has to be drawn from the boiler through a long and sinuous pipe during the short period of admission which in an ordinary Corliss engine is only one-fifth to one-quarter of the stroke, has always been a source of annoyance to engineers. This reduction of pressure, as shown by indicator cards, generally amounts to from 5 to 10 per cent. of the boiler pressure.

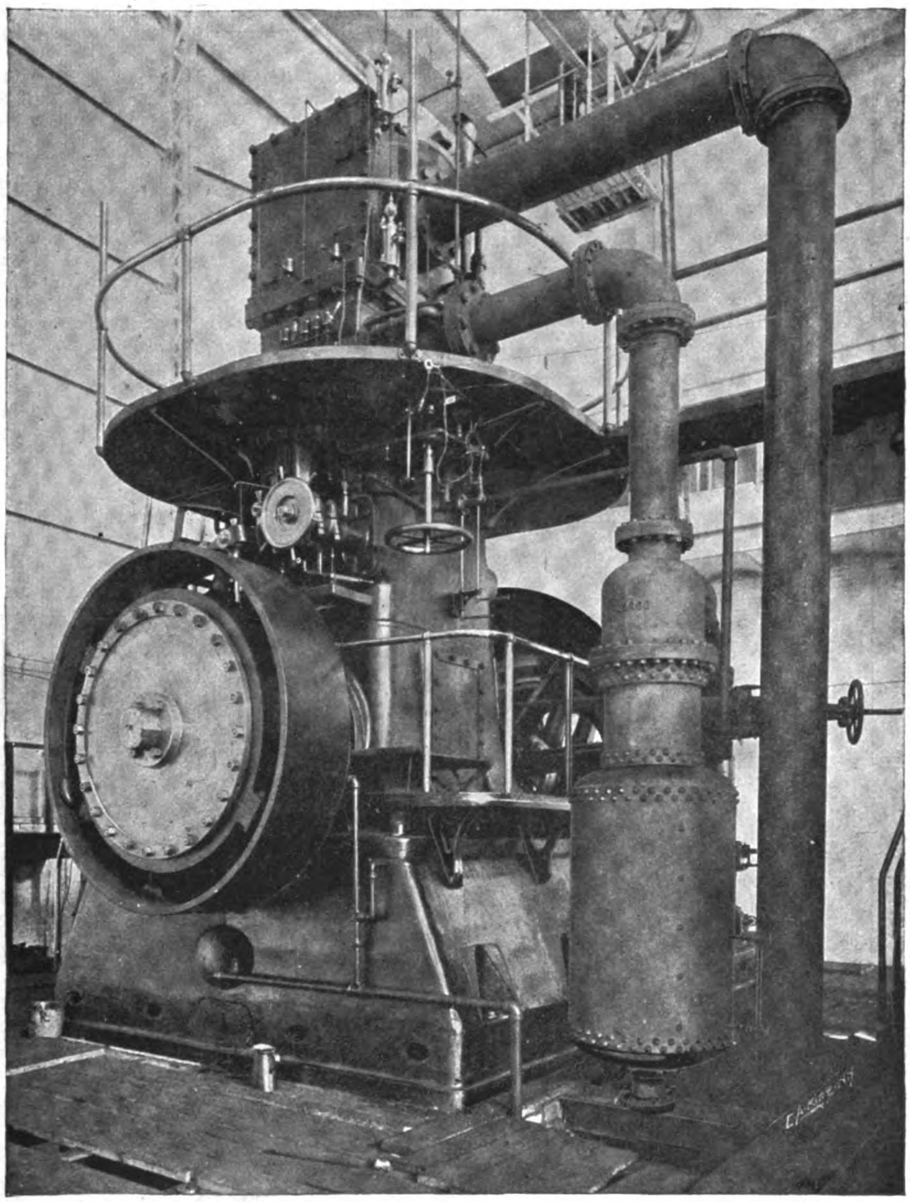
Using very large steam pipes reduces the loss only in a measure, while open to the objection of increased cost, greater difficulty in keeping the joints tight, especially under high pressures, and greater liability to accidents; steam pipe explosions having unfortunately been too frequent of late.

In view of all this it has become the practice in large plants to place a large reservoir or receiver close to the engine; thus insuring a free supply of steam at substantially full pressure during admission, the boiler having ample time during expansion to again restore the pressure in the receiver.

A receiver of this kind for high pressures has to be specially designed and exceedingly well made. Its construction cannot be entrusted to any ordinary boilermaker; as it is an engine-room appliance nicely covered and lagged, the slightest leak must be avoided.

All these considerations have led the Goubert Manufacturing Company of New York, manufacturers of the Stratton steam separator, to design a combined separator and steam receiver. The making of the two appliances in one, while insuring a supply of perfectly dry steam at full pressure to the engine, economizes space and makes a much neater appearance, as well as lessening the number of joints that would be necessary if two different apparatuses were used. The large experience and manufacturing facilities of this company for high-pressure work are a guarantee that nothing but good and tight work, with a safe and efficient apparatus will be furnished.

The Goubert Manufacturing Company have already supplied these combined separators and receivers to a number of large power plants. Among them may be mentioned the United Electric Light and Power Company of New York, West End Railway Company of Boston and Nassau Electric Railroad Company of Brooklyn.



STRATTON COMBINED SEPARATOR AND STEAM RECEIVER.

The accompanying engraving shows one of four of these Stratton combined separators and steam receivers connected to 1,200-horse-power Westinghouse engines at the new power house of the United Electric Light and Power Company, East Twenty-eighth street, New York City. The following extract from a letter to the Goubert Company from the chief engineer of the United Electric Light and Power Company, Mr. H. W. York, may prove interesting:

"The form of combined separator and receiver furnished by you for the Twenty-eighth street station of this company has proven most satisfactory in every respect.

"The separators remove practically every trace of entrained water, while the receivers keep a constant supply of steam right at the throttle, which is not affected in pressure by the pulsations of the engine to an extent of over one-half of one per cent.

"I have made several tests to ascertain the drop in steam pressure between the boilers and the receivers, and even when the engines are loaded I cannot find any appreciable drop. In making these tests I have used two indicators, which were first placed on the steam pipe, side by side, and ascertained to be precisely alike; then one placed on the separator and one on the steam header in the boiler room. Cards were taken from these indicators at the same instant, and after the experiments were completed the indicators were again calibrated and found to agree. In all these tests the difference in steam pressure at the two points was scarcely discernable.

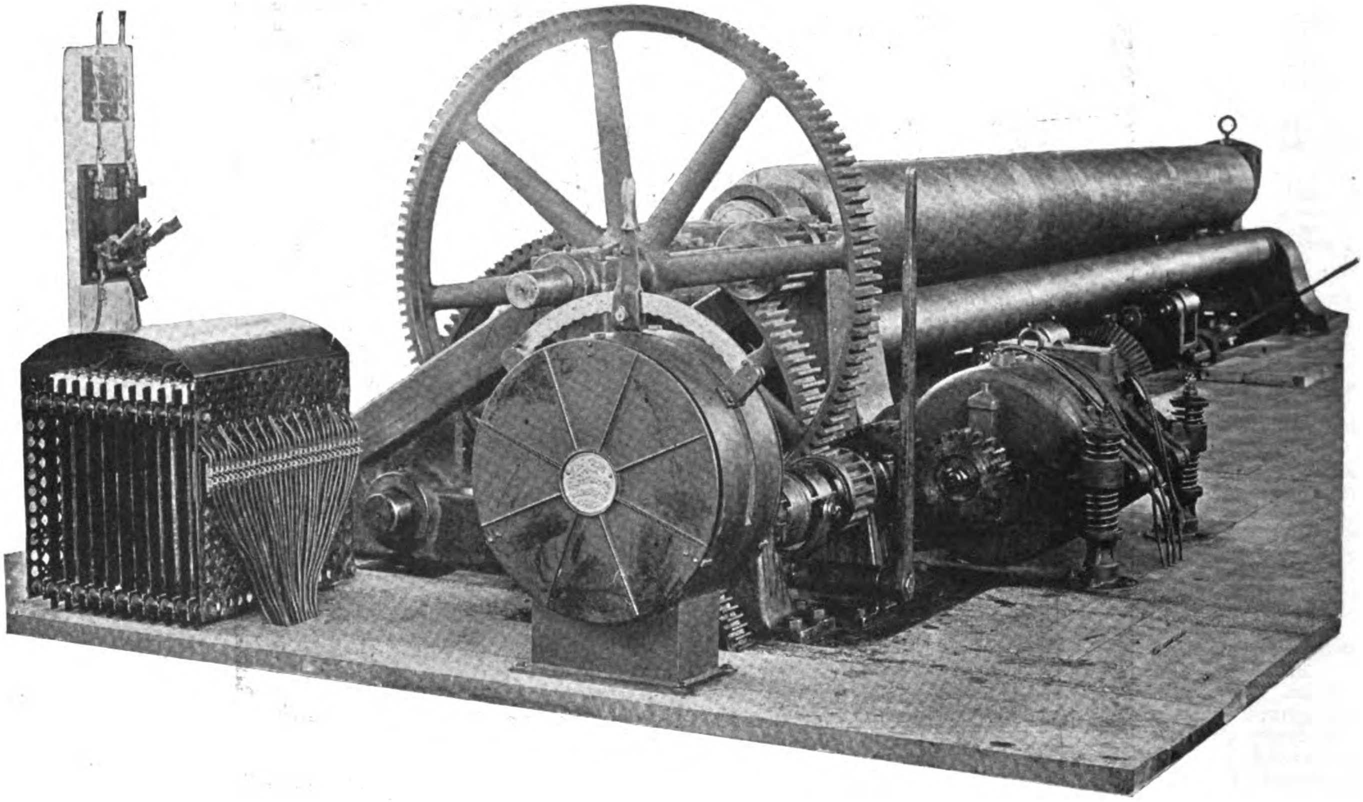
"I may also add that in consequence of maintaining a constant pressure at the engine there is practically no vibration in the steam pipe."

POWER TRANSMISSION.

BENDING ROLLS OPERATED BY THE CARD SERIES REVERSIBLE MOTOR.

THE accompanying engraving shows a 30-horse-power series reversible motor, controller and rheostat attached to bending rolls capable of bending iron plates 20 inches long by ¼ of an inch or more in thickness. The electrical apparatus illustrated in connection with the bending rolls is manufactured by the Card Electric Company, Mansfield, Ohio.

The motor is of 30-horse-power capacity, at a speed of 325 revolutions per minute under full load. It is geared direct to a shaft, carrying a clutch, which is operated by a vertical lever, which engages in two trains of gearing, as desired; one for revolving the two lower rolls and the other for raising and lowering the upper one. As the motor is reversible, the manipulation of the rolls for bending plates on any circle is easily and quickly accomplished, and with great accuracy. The rheostat is made up of iron wire in an improved form, and has a capacity to carry the full current of the motor under all loads and at any speed. The resistance is sufficient to permit reversing the motor at full speed and under all conditions. The controller is particularly adapted and arranged for series-wound motors, where close regulation of speed, sudden stops and quick reversals of motor are required. All the working parts are made amply large on account of the severe work necessarily required of such apparatus. The circuit is opened at twenty-four contacts, breaking in unison, reducing the spark to practically nothing. Twenty-nine contacts are provided for regulating the speed. By means of this construction any desired speed can be had and maintained. The resistance being so subdivided and the contacts so arranged for cutting portions of it in or out that arcing over and blistering the contacts is impossible.



CARD MOTOR DRIVING PLATE BENDING ROLLS.

POWER TRANSMISSION IN THE INDIAN TERRITORY.

The Purcell Electric Light and Water Company, Purcell, I. T., has quite recently put in a plant for local work and is now putting in wires and poles for operating at Lexington, O. T., in connection with the same plant. Current will be carried a considerable distance, at one point crossing the Canadian River some 4,080 feet from bank to bank. The officers of this enterprising company are J. Taylor Bradley, T. W. Brannon, and W. I. Brannon.

THREE-PHASE PLANT IN A SOUTHERN COTTON MILL

The electrical equipment of the extensive cotton mills of the Pelzer Manufacturing Company, one of the largest cotton goods manufacturing concerns in the South, is rapidly nearing completion. The motive power is derived from Victor turbine water wheels, driving three 750 kilowatt three-phase generators, wound for 3,300 volts. The water wheels turn at a speed of 164 revolutions per minute.

The electricity generated at the power house will be carried a distance of three and a half miles to Pelzer, where it will enter the mills and drive the following motors: One 400 h. p. synchronous motor wound for high potential and several multi-phase motors of varying capacities from 5 h. p. up to 110 h. p. The majority of these motors will be of the inverted type, suspended from the ceiling in the different rooms. They will receive the current at a low potential from step-down transformers, placed in the substation at the mills. The mills will also be lighted from the same circuit.

The system utilized in the operation of these mills is the three-phase system, developed by the General Electric Company. It is the same system in use at the Columbia mills at Columbus, S. C., and at the Ponemah Mills at Taftville, Conn.

MISCELLANEOUS.

THE BALDWIN ELECTRIC METER.

NOTHING is so comforting to a station manager as the knowledge that his customers' meters are accurate, in the first place because it insures the proper income for the station output, and secondly because it removes the annoying complaints of overcharge by customers.

The Baldwin Electric Meter Company, of Washington, D. C., have just placed on the market a recording electric meter, of decided novelty, which is claimed to possess in a high degree the valuable qualities of reliability and accuracy. The meter is

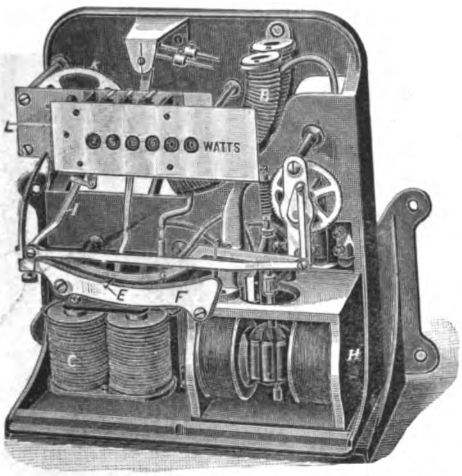


FIG. 1. THE BALDWIN ELECTRIC METER.

constructed so as to cut itself in circuit on one lamp, and to register that one lamp with as much power and certainty as its full capacity of lamps. It can also run slow or fast, above the normal speed or below the normal speed, and yet the current consumption can always be read with positive accuracy within 1 per cent.

Our engraving, Fig. 1, shows the construction of the meter. The current enters at the binding post A, and traverses the solenoid B, and cut-out C, and then takes its exit at the binding post D. The solenoid operates in the usual way to swing a fulcrum pointer E, whose zero point is at the left hand end of the backing plates F. Above this fulcrum pointer is a cam-shaped lever G, whose right hand end is reciprocated periodically by the motor and crank movement,

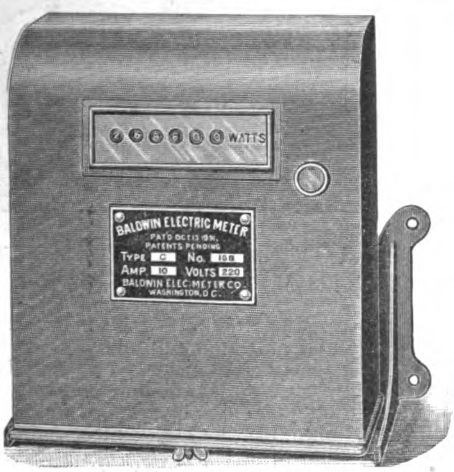


FIG. 2. THE BALDWIN ELECTRIC METER.

and whose left hand end is connected by the connecting rod I, to the ratchet wheel K.

When one or more lamps are turned on the circuit, the armature of the cut-out, C, shown at hte botom, is brought down on its contact, thus putting in circuit and starting at full power the motor H, the fulcrum E also at the same time moving forward, taking position further and further to the right as more and more current is turned on the circuit. The binding post, near cut-out C, connects with one side of the circuit and the spring contact through the motor with the other side.

As the cam lever G, is reciprocated by the crank movement, it strikes the fulcrum pointer, which is bent down until supported by the backing plates F, and the left end of the cam lever is lifted up by the connecting rod I, which movement is communicated to the ratchet wheel and registered on the counter L.

It will be seen that the more current on the circuit the further to the right the fulcrum pointer takes its position and the greater will be the movement of the cam lever and the greater the rotation of the ratchet wheel. The cam lever is so designed as to give rotation to the ratchet wheel proportional to the current passing through the meter, and great accuracy is obtained throughout the whole range and capacity of the instrument. When the cam lever is in its uppermost position, the fulcrum pointer touches no part of the instrument and it is perfectly free to take up a new position which indicates a change in the current strength.

The motor H has power greatly in excess of its required work, being an efficient and well constructed iron motor. Although taking but 7-100 ampere, it always runs at its full power, has good brush contact on the commutator, and maintains its speed very close to the normal, being connected independently directly across the mains. For any motor speed accurate readings of current consumption may always be had by taking the motor speed in the following way: The normal crank speed is 3 revolutions per minute or 5 revolutions in 100 seconds, and if 5 revolutions of the crank are timed and it is seen that such 5 revolutions take place in 105 seconds, the motor is running just 5 per cent. slow, and 5 per cent. should be added to the counter reading for obtaining an accurate result. If the crank should show 5 revolutions in 97 seconds, the motor is running 3 per cent. fast and just 3 per cent. should be subtracted from the reading of the counter in order to obtain the true final consumption of current. Great accuracy is thus obtained for any motor speed.

The meter has a slow speed motor, making 300 r. p. m., and requires little attention; it is very economical since no current is consumed in the meter itself when no lamps are on the circuit. The meter shown in the cut is for the two-wire direct current system, and the three-wire meters are constructed in the same way with two solenoids. The engraving, Fig. 2, shows the meter enclosed in its protecting case.

THE GENERAL ELECTRIC CO.'S EXHIBIT AT ATLANTA.

THE central space in Electricity Building at the late Atlanta Exposition was occupied by the compact and well-arranged exhibit of the General Electric Company, illustrating the latest developments in the fields of electric lighting, railway and power.

The exhibit, which is illustrated in the accompanying engraving, was erected on a raised platform surrounded by a cornice supported on columns of white enameled iron. The cornice was decorated with a row of miniature purple lamps breaking into groups of amber lights over the caps of the posts. The side of the cornice facing the exhibit was ornamented with a line of frosted lamps.

The railing was an exhibit in itself, made of lengths of one-inch brush-holder cable, stretched between standard insulated railway turnbuckles. It was supported on posts capped with General Electric insulators. At the ends of the platform the place of the cables was taken by nickel-plated trolley wires supported on high tension porcelain insulators of the double-petticoat pattern, similar to those used for the Sacramento-Folsom plant. The roof of the office, which stood in the center of the space, was decorated with a large model of an Edison lamp socket, three feet high, in the construction of which not less than 700 standard sockets were used.

The office stood under an arch—one of the most interesting features of the exhibit. It was a model of the upper field of one of the large 800 k. w. monocyclic generators now running in the station of the Edison Illuminating Company, St. Louis, Mo. The model is full size, 21 feet in diameter. These generators are the largest that have ever been constructed and operated. As erected here, the armature could be set upon the floor and just fit the field frame in its present position. The supports for this model were two large pyramids, the four sides of which formed display boards on which were artistically arranged fine selections of the many lines of railway, power and lighting supplies made by the company.

While the visitor was impressed with the model of the great monocyclic generator field, an opportunity was also afforded him in viewing the monocyclic system itself in actual operation. A monocyclic generator of 250 k. w. capacity ran day and

night in Machinery Hall and supplied current for the illumination of a large portion of the halls and buildings, as well as for the operation of 30 and 50 h. p. induction motors. The visitor was thus enabled to judge of the flexibility of the system from personal observation.

One corner of the exhibition space was occupied by a 30 horse power three-phase induction motor driven by current from the monocyclic generator just mentioned. The motor is started by the closing of a switch and comes to full speed quickly. This motor drove a 20-kilowatt, 125-volt, four-pole, slow-speed generator, furnishing current to illuminate two signs, each forty feet long, conspicuously hung below the balconies opposite each end of the exhibit. The name of the General Electric Company was spelled in eight-candle-power lamps and stood out prominently in neat white script against a black ground.

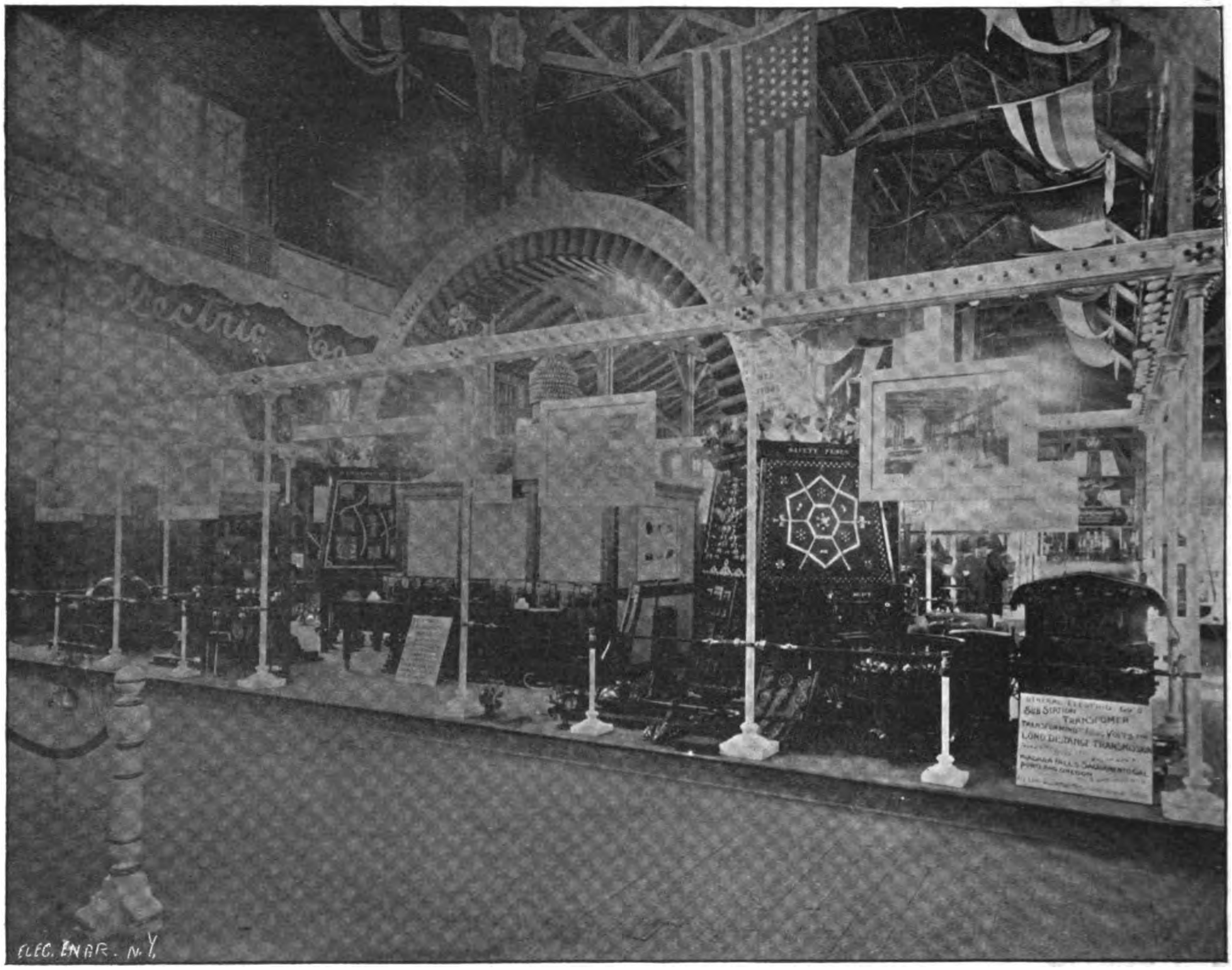
A full set of the latest type, plain and ornamental, arc lamps for incandescent circuits were shown hanging from a stand of wrought iron scroll work. Several arc lamps intended for use, ten in series, on 500-volt railway circuits, were also shown. This display of arc lamps also included the alternating current arc lamp, reported to be meeting with success throughout the country. The arc lamp exhibit was further increased by a full display of the apparatus and devices necessary in arc light service.

The marine work of the General Electric Company was represented by a small plant, consisting of an engine and a generator, directly connected, and a switchboard adapted to marine requirements. The complete plant illustrated the compactness necessary in all electrical work on shipboard.

One corner of the space was devoted to railway appliances, including, of course, the trio of G. E. motors; the G. E. 800 for ordinary street car service, the G. E. 1,200 for suburban service and the G. E. 2,000 successfully used on electric elevated roads and those branches of steam lines fortunate enough to have adopted electricity. Car controllers of the well-known "K2" style were shown, together with a large "L" controller, designed for use with the G. E. 2,000 motor. A well-arranged panel switchboard with full equipment of automatic circuit breakers, quick brake switches, indicating and measuring instruments rounded off the railway exhibit.

The line of transformers was represented by a sample of each size, from the small 350 watt transformer for six lights to the 30,000 watt transformer for 600 lights. A 250 k. w. transformer of the air blast type was also shown. This type of transformer has been introduced for sub-station work to transform up to, and down from, very high voltages in long-distance transmission work. Many are now in successful use at Portland, Ore., Sacramento, Cal., Niagara Falls, N. Y., and Lowell, Mass.

Samples of wire and cables made by the company in its works at Schenectady were shown in mahogany cases, and the system of underground tubes, used in Boston, Chicago, New York and other places, was exemplified by many fine samples of tubes, conductors and subsidiary appliances.



THE GENERAL ELECTRIC COMPANY'S EXHIBIT AT THE ATLANTA EXPOSITION.

(To be repeated at the New York Electrical Exposition.)

Thomson recording wattmeters occupied a small department by themselves and every size was shown, from the smallest to the largest, including some fine samples of the large station meters which record an output as high as 8,000 amperes. Samples of fan motors, small bi-polar generators and motors with cylindrical field frames were also exhibited.

Hung around the exhibit were a number of enlarged photographs, illustrating the work done by the General Electric Company. Each enlargement was framed in white and an examination of these pictures alone would give an excellent idea of the extent of the General Electric Company's factories, as well as the important installations throughout the country in which its apparatus is used. From these pictures the visitor also gained a good idea of the recent developments in electrical practice, as the photographs included the interior of the Portland (Ore.) power station, the conduit railway system on Lenox avenue, in New York City, the Nantasket Beach (Mass.)

road, the elevated roads in Chicago, and the great electric locomotives now operating on the Baltimore and Ohio Railroad.

In addition to the exhibit in Electricity Building some standard machines were in operation in Machinery Hall. These included the monocyclic generator, already referred to, a single-phase alternator, a Thomson-Houston arc machine, and a large bi-polar generator.

The searchlights on the roof of Machinery Hall and on the tower of the Government Building, the lamps which operated the electric fountain and its complete electrical equipment, the Tower of Light which floated in splendor on the lake, were all parts of the comprehensive exhibit of the General Electric Co.

The following awards were made to this company: Two gold medals for (1) photographs and description of the Baltimore and Ohio locomotive and (2) generator, motors and lamps operated by the monocyclic system; 6 silver medals for (1) T.-H. arc light system; (2) T.-H. alternating light system; (3) Edison lighting system; (4) street car system; (5) Thomson recording wattmeter; (6) Brush arc light system. Honorable mention for (1) portable alternating measuring instruments; (2) direct connected marine set; (3) searchlights; (4) insulated wires and cables.

ELECTRIC HEATING.—III.[1]

(Concluded.)

BY W. S. HADAWAY, JR.

The car heating tests made show that with the use of about four horse power the interior of the car can be kept practically at 50 degrees F. From one point of view this is too low a temperature for comfortable passage. And yet if the heater is devised to deliver a part of its energy to the floor of the car, to keep it warm and dry, and about the limbs of the passengers, this is high enough for practical purposes. The problem of car heating practically resolves itself into providing a form of foot warmer heated by electricity and used for effective warming rather than for heating per se.

On the Esquimaux plan of huddling together for warmth, a car can be kept at about 40 degrees F. by animal heat; each adult passenger gives off 190 heat units per hour, or 14 passengers will give off as much heat as one electrical horse power hour. There are cases in practice in which the animal heat on some runs is practically the equivalent of the electrical energy used in heating. Clearly, then, the proper use of electrical energy is on the basis of individual effectiveness rather than for heating as commonly understood.

Using the methods commonly employed for computing the heat necessary for warming, a 20-foot car requires eight horse power hours to keep it at 65 degrees with the outside air at zero. In the cars examined in use the energy supplied for heating by electricity was about equal to the loss from glass radiation. There are cases in which the energy used for heating by electricity is 40 per cent. of the energy used in operating a particular car. And yet, assuming that five horse power is a fair average for use, the cost is about $10 per month per car for heating, or about 33 cents per day or 2 cents per hour. The use of five horse power is a high one for effective warming, as it would heat 37 square feet of radiating surface to 185 degrees with the car at 50 degrees, while with the best systems of radiation for complete diffusion yet suggested the surface available is about 30 square feet, requiring four horse power to heat.

While most of the electric car heaters now supplied do not meet the conditions here imposed, the fact that several thousand cars are equipped with and are using the heaters attests their value. I beg to quote in this connection from a letter written me by a well-known street railway expert:

"I think that the decision for or against heating in any particular case will have to be given with the distinct understanding that collateral advantages and not coal economy form the real criterion. You will remember that I spoke to you about a large plant which had been using heaters this winter with a very great expenditure of power. I had a talk with the manager a few days ago with the following results: He admitted immediately that it is costing him considerably more, in fact, about four times as much, to heat his cars by electric heaters as it did by coal stoves. He says, however, that he saves two seats in the car; that the people like the system of heating, and the cars are more attractive for this reason, and that on the whole he believes in it and would not go back to the old system, nor would he fail to adopt electric heating if the decision were to be made again."

This expression of opinion has been selected, notwithstanding the unfavorable comparative cost statement, to illustrate how far we have to be governed by collateral advantages in deciding for or against any particular application of electricity for heating purposes.

More large contracts for electric car heaters have been closed the past season than ever before ,and there is every evidence that the electric car heater has become a staple commercial device. It would seem, in view of the facts, that the statements contained in Vol. I of the transactions of this society regarding electric car heaters should not stand without correction. The Metropolitan West Side Elevated Railroad of Chicago are now heating by electricity 155 cars, each 38 feet 8½ inches long; 7 feet 10 inches wide; center height, 8 feet 6⅞ inches; side height, 6 feet 7¾ inches. Glass surface is 208 square feet. There are 12 heaters to each car, using maximum of 7,000 watts. The energy used is divided in two parts of 2,600 watts each and one part of 1,800 watts. The practicability of the equipment is shown by a recent order for 25 more equipments.

II. Air Heaters.—Outside of car heating these heaters have been used to a wide extent. One of the largest installations is in the office building of the Cataract Construction Company, at Niagara Falls, where all the heat is derived from this source. In cabins of steamships and yachts, bath-rooms of houses, offices, libraries, etc., they are found useful devices. The writer pointed out in "Heating and Ventilation" for December, 1895, the relation which these heaters bear to steam heating systems.

In England and France some installations have been made on a considerable scale, and the work is, of course, simpler than the problem confronting us in this latitude, where the maximum capacity requires to be nearly twice the average. In heating the Vaudeville Theater in London, the engineers write that they had to compete against a low pressure hot water system. There was difficulty in finding a suitable place for the furnace on that system, and in using electricity this difficulty was overcome. It is found in ordinary cold weather that only two or three hours' heating are required, but with hot water systems it is impossible to limit the time in this manner, as the water takes two or three hours to heat up and the same time to cool down. The charge for current is 4d. per unit (about 6 cents per horse power hour). The lessees of the theater have expressed themselvs perfectly satisfied with the results.

In this work the fact that heat is used only intermittently produces economical results, with even very high current rates. Take the case of a bath-room; capacity of heater, one horse power; duration of use per day, 20 minutes; rate for power, 10 cents per horse power hour; cost per day 3 1-3 cents, or practically $1 per month.

III. Electric Cooking.—The results obtained in this line have been in a number of detached installations. Enough has been accomplished to show that electric cooking apparatus is practicable to use, economical in running cost, and extremely simple to operate.

Theoretically, of course, the oven is the device of highest efficiency, and it is also found in practice a device of the greatest practical value. In "Science" for September 15, 1893, will be found the most comprehensive data regarding the comparative cost of operating the electric oven and the common coal range yet published. It is shown that the cost at average rates for electricity is practically the same for the coal range and electricity, provided an auxiliary water heater is used with the electric oven. It is not always possible in practice to confine the electrically heated apparatus to types as economical as the oven; but in a plant operated for several months and in which ordinary types of cooking utensils were used, the cost was found to be 2.5 cents per person per meal. Separating the energy used in this latter case for cooking from that employed for water heating and the cost would be reduced by about one-third, or to 1.7 cents per person. Even at the 2.5 cent rate the cost (including time and attendance) compares favorably with other sources of heat for cooking.

IV. Industrial Applications.—In factory work all the elements for a multipotential heat supply are usually present and the field for electrically heated devices extensive. Three examples have been selected as illustrating this class of work.

A Equipment of a Brush Factory.—In this instance pitch is used to fasten bristles in the brushes, and is kept above 300 degrees F. in jacketed electrically heated pans. In addition, hot plates and glue pots are used, all heated by electricity. Current is derived from a dynamo driven by a gasoline engine. For a run of ten hours the cost of heating each pitch pan is about 4.5 cents, which is considerably less than was the cost of running by gas.

Commenting on this plant, the owner writes:

"When we built our factory we had confronting us the problem of obtaining high temperature for heating pitch and other applications without employing gas or other forms of flames or fire in the shop which were objectionable from the underwriters' standpoint, and which we have solved by the adoption of electricity for these purposes."

1 Abstract of paper read before the Am. Society of Heating and Ventilation.

B. Sad-irons in a Linen Factory.—This installation consists of 125 9-pound irons heated to about 750 degrees surface temperature. For this plant additional dynamos were bought, and its success is evidenced by the fact that it is shortly intended to double the equipment. Each iron uses 550 watts, or about ¾ horse power per hour as a maximum.

C. Glue Pots in Book Binderies.—Two installations of 25 pots each. These show the value of electric heating in the subdivision of heat energy. The pots are provided with water bath, and the energy supply so adjusted to compensate for heat loss without material evaporation. The energy used by each pot is from 150 to 200 watts.

These may be regarded as typical illustrations and indicate roughly the adaptability of electric heating in industrial work. Where electricity is used in place of flame or fire the ventilating problem becomes much simpler, and this is of great importance in crowded work-rooms.

It is not too much to claim that electric heating will materially influence the work of heating and ventilating engineers. Now that electric lighting installations are handled by heating and ventilating engineers, it is a short step to render the entire heating system homogeneous, looking to one source—the boiler—for all the energy needed for heating, lighting and ventilating. It is possible to economically regulate and provide storage capacity for both the high and low temperature factors; the plant becomes compact, self-contained, and simple and economical in units of moderate size. The system is elastic to the highest degree.

THE GENERATION AND DISTRIBUTION OF CURRENT BY AN EDISON STATION.[1]

THE author began by giving a brief account of the inception and early history of the Edison Electric Illuminating Company of New York, in connection with the operation of the old Pearl street station, which was started September 4, 1882, and details of which will be found in "The Electrical Engineer" of January 8, describing the work of the company. The author then continued:

Before proceeding with a description of this station, it may not be inopportune to give a few thoughts to the general problems involved in the modern station from an engineering point of view. The operations involved in the business of the supply of electric current from a central station for transformation into heat, light and power divide themselves readily into two broad divisions—generation or manufacture, and distribution or subdivision.

The generation or manufacture of current includes the cycle of operation conducted within the station itself, involves the transformation of the heat energy stored in the coal into dynamic energy, its transformation into electric energy, and its delivery to the switchboard. The operations involved in the distribution of the current are effected mainly without the station, and involve its delivery through a network of mains and secondary conductors to the local centers of consumption, where, through translating devices, the current is transferred into the form of energy desired—light, or dynamic energy.

The various processes involving the generation of electric current on a scale rendering possible its industrial utilization are, except where water power is available, the direct results of chemical action, usually the combustion of coal. The operations a central station conducts are the economical burning of coal, the imparting of its heat energy to the water in the boiler converting it into steam, the dynamic force of which impels the piston of the engine, resulting in the movement of conductors through the lines of force of an electro-magnet, thereby generating electric current.

Of the several steps of this cycle, the important ones are mechanical. The economical burning of coal on a grate, although a chemical process, has been reduced by accepted types of boiler furnaces to a mechanical operation requiring some common sense and a stout arm, but no chemical formula. The electric generators involved are relatively simple, and the perfection to which electrical construction has already attained has confined further possibilities in this direction to improvements affecting the investment rather than operating accounts. I speak of this somewhat elementary proposition for the purpose of calling to mind and emphasizing the fact that in the modern central station the problems within the station—problems of generation or manufacture—are in mechanical rather than electrical engineering. The best types of multi-expansion condensing engines rarely transform more than 15 per cent. or 16 per cent. of the heat energy of the coal into dynamic energy, and, in the common forms of non-condensing engines, not more than 6 per cent. of the coal energy is available at the flywheel of the engine. Under the conditions found in most electric light stations, these efficiencies cannot be approached. Taking into account the variable loads on engines and boilers, condensation in steam pipes to the power required for the auxiliaries, with the other losses, the total efficiency of the transformation into electric current seldom, if ever, exceeds 8 per cent., and is usually not greater than 3 per cent.

The electrical efficiency of the best types of dynamos of the size used in the larger stations is seldom less than 90 per cent., and, in the larger sizes, is as high as 96 per cent. These efficiencies diminish but little under the partial loads ordinarily carried in a well-designed station having generating units of several sizes to maintain a high ratio of capacity to output. With the generators at this (Duane street) station it is possible to obtain a ratio of output to dynamo capacity in operation of 92 per cent. between the hours of 9 a. m. and 6 p. m.; during the twenty-four hours this ratio is reduced to an average of 85 per cent, as the smallest unit available has a capacity considerably in excess of the requirements during the minimum hours. Exhibit: Blueprint diagram of capacity and load curves at Duane street station.

It is safe to say that of the energy delivered to the engine shaft, from 75 per cent. to 85 per cent. in the smaller stations, and from 85 per cent. to 90 per cent. in the larger, is delivered as electrical energy to the switchboard, including losses due to the inefficiency of the dynamos, in the leads to the switchboard, in the contacts, etc. It is evident, therefore, that the losses due to the inefficiency of the electrical apparatus in the station are small as compared with those due to the inefficiency of the apparatus engaged in the conversion of heat energy into dynamic energy, and in the auxiliary apparatus the great problem in the mechanical operation of a station is to reduce these losses to a minimum, approaching as nearly as possible the conditions of maximum economy—the coal consumption, per unit generated, approaching what its value would be if the whole station were operated at the load of maximum efficiency for the twenty-four hours.

The problems which are more specifically electrical in their nature are those connected with the delivery of the current from the switchboard into the system of mains and feeders which distribute the current to the consumer's premises and its transformation there in the form of energy desired. I will not undertake to point out here the numerous methods available for effecting this end, but will confine myself strictly to the system under consideration.

The loss of energy in the conduction of current from the switchboard to the point of consumption depends upon the factors, current, pressure, sectional area of conductors and their length. For each particular case there exists a fairly definite relation, from which, given the cost of producing the current, the average use of current, or the load factor, the distance to the point of consumption and the cost of the conductor per unit area, the most economical section can be determined. It would, of course, be out of the question to make this calculation for each consumer, or group of consumers, but it must be taken into account when it is a question of supplying current at considerable distances from the station. Erroneous ideas are held as to what the actual losses are in a network of feeders, mains and services distributing current from an Edison station. It may be interesting to note that the drop of voltage, due to resistance of conductors between the switchboard and the consumers' services, on the Edison system in New York amounted to an average of 7 per cent. during 1895. To this should be added an average drop of 2 per cent. to 2½ per cent. on the consumers' wiring between the services and the lamps. This drop has been reduced considerably, as well as the investment cost for conductors, by the use of two or three "bus" pressures in the modern station, grouping the distant or heavily loaded feeders on the "bus" carrying the high voltage, and the short or lightly loaded feeders on the low "bus." The same result is obtained by the use of a "booster" inserted in series with the feeder, which adds to the "bus" pressure the voltage necessary to overcome the drop.

Notwithstanding the much-talked-of leveling of the station load curve due to the installation of motors, it will be found that as a station increases in capacity the ratio of maximum load at any time to the total connected installation will continue to fall. There is a limit, of course, beyond which this decrease is not likely to go, depending largely on the further uses to which electricity will be applied.

In an industrial district, where the motor load is heavy nearly all day, the lighting load is comparatively light, except during the winter, when darkness sets in early, and the motor and lighting loads overlap. In a district of this kind, moreover, there is but small demand for light at night. In a residential or shopping district, on the contrary, the motor load is of less importance, and the lighting load becomes great immediately upon the approach of darkness, reaching a maxi-

[1] Abstract of a paper read before the N. Y. Electrical Society, Feb. 26, 1895.

mum in the evening and extending some into the night. (Exhibit.)

These characteristics are clearly shown by the two curves of the diagram before you, one representing the load of the First District, extending from the Battery to Fourth street, the other, the load of the Second District, extending from Fourth street to Eightieth street, on the East Side. In the First District motors represent nearly 42 per cent. of the total installation, and the output to motors during last year was nearly 45 per cent. of the total output of the district. The ratio of maximum load at any time to connected installations varied from 21 per cent. in summer to 38 per cent. in winter, the load factor—the ratio of average load to maximum load—averaging about 26 per cent. during the entire year. In the Second District the motors represent only 17 per cent. of the total installation, and the current delivered to them during the year represents only 16 per cent. of the total output of the district. Yet the percentage of maximum load to connected installation varies from 16½ per cent. in summer to 38 per cent. in winter, while the load factor exceeds an average of 30 per cent. --more than 4 per cent. higher than the average of the First District.

It is interesting to note that the daily average use of each incandescent lamp installed is almost identical with the daily average use per rated horse power of motors installed. This fact, if taken alone, would be misleading; it should be remembered that an incandescent lamp is used at its full candle power, whereas the current consumed by the motors will average less than one-fourth or one-third their rated capacity.

Although motor service is, on the whole, advantageous to a station, owing to the long average use in proportion to the time of maximum current demand, and can, therefore, be sold at a considerably lessened rate than in the case of arc or incandescent lighting, it is not an ideal service. This is due to the fact that the motor load overlaps the period of maximum demand for lighting, and, therefore, becomes part of the maximum load on the station, for which generating and distributing capacity must be provided. The ideal service for leveling the load curve, which all station managers are striving to do, is one which ceases before the time of maximum lighting, and which would not, therefore, call for additional and special investment. It is hoped that some such application may appear in the many uses which are being found from time to time for the electric current. (Additional Exhibits: Comparative output of London, Berlin and New York Edison stations. Characteristic output curve of each month of the year. Curve of monthly variation of maximum, average and minimum loads. Loads on special days: Christmas, Fourth of July, heaviest load during year, etc.)

Owing to Mr. Lieb's illness, the part of the paper referring specifically to the Duane street station was not finished. Mr. R. R. Bowker, first vice president of the company, addressed the meeting, pointing out the characteristic features of the station construction and equipment.

PERSONAL.

A PRESENTATION TO MR. W. J. FRASER.

On February 25 the staff of the Direct United States Cable Company at Rye Beach and Boston presented Superintendent W. J. Fraser, of Rye Beach, with a solid silver, triple-handed loving cup, as a token of their high esteem and in commemoration of his service at that place for twenty years, from 1876 to 1896. The cup bore a fitting inscription. It was accompanied by a handsome cake, with similar inscriptions, and entwined with strands of cable in the form of true lovers' knots.

After this Mr. J. C. Shaw, of the Boston Cable staff, presented Mrs. Fraser with a splendid bouquet in the name of the officers of the well-known cable steamer, "Minia" (Anglo-American Company), many of whose officers were present. The remainder of the evening was spent in a delightful manner at Mr. Fraser's residence, with music, games, dancing and refreshments, the party being large and representative.

AN ELECTRICAL ENGINEER ON HIS TRAVELS.

Mr. T. Ahearn, wife, two children and maid, of Ottawa, Canada, are staying at the Bristol, having arrived per steamer "Oceana" from Sydney on the 13th instant, since which time Mr. Ahearn and family have visited Nuwara Eliya and Kandy, and they speak flatteringly of Ceylon. Mr. Ahearn is a prominent Canadian electrical engineer, and is closely identified with a number of the largest electrical enterprises in the Dominion, his firm, Messrs. Ahearn and Soper, having pioneered the electric tram in Canada, and having installed extensive plants in the principal cities of that country, where electric traction has entirely superseded the horse. The trams are successfully operated on wheels throughout the winter, when vast quantities of snow fall, as huge rotary snowsweepers propelled by electricity keep the tracks clear. Mr. Ahearn will continue his trip around the world, sailing for Calcutta in the "Nubia" on Thursday next, and, after crossing India by rail, will sail from Bombay for Europe.—"Times of Ceylon."

LETTERS TO THE EDITOR.

THE COMING CONFERENCE ON UNDERWRITERS' RULES.

On behalf of the Committee on Standard Rules for Electrical Construction and Operation of the National Electric Light Association, I write to state that after mature deliberation it has been decided to extend an invitation to the Underwriters' National Electric Association to send a delegate to the joint conference to be held on March 18 and 19. This association has been added to the list of eleven organizations already co-operating which was published in the recent issue of your journal. Our committee was led to this action which has been under consideration for some time past by reason of the fact that they felt that while the insurance interests of the country would be ably taken care of by the representatives of the National Board of Fire Underwriters, and although they realized that the Underwriters' National Electric Association, acting merely in an advisory capacity, being composed of the electrical inspectors from all parts of the United States and having no authority in itself as an association, so closely were they identified with the preparation, indorsement, and enforcement of rules for electrical construction and operation and so alive to the practical questions which would come before the joint conference, that the committee felt it advisable to extend an invitation to their organization to send an official delegate on the same par with the eleven other interests already invited.

I append herewith a list which has been prepared of complimentary delegates to be invited to the joint conference in an advisory capacity, but solely as individuals and not as representing any association or manufacturing interests: Wm. McDevitt, Inspector Board of Fire Underwriters, Philadelphia, Pa.; A. E. Kennelly, Consulting Engineer and Expert, New York; W. J. Jenks, Electrical Engineer and Expert, New York; A. H. Henderson, Chief Inspector Fire Department, New York; Morris W. Mead, Superintendent Bureau of Electricity, Pittsburg; Professor Wm. A. Anthony, Consulting Engineer; E. H. Johnson, New York; S. E. Barton, New York; E. V. French, Inspector Factory Mutual Fire Insurance Company, Boston.

The committee has in preparation a transcript of the various codes most extensively in use, and this, in a convenient and compact form, will be in the hands of each delegate prior to the meeting, at which meeting a large amount of additional matter bearing upon American and European practice will be available, and it is the intention that in the consideration of the various rules presented at the joint conference, the decision as to what shall be adopted for the national code will be governed solely by the law of the "survival of the fittest."

W. J. HAMMER,
Chairman Committee National Electric Light Association.
New York City, March 6.

CONTAINS THE NEEDED INFORMATION.

"The Electrical Engineer" possesses one feature which makes it invaluable to the up-to-date electrical fraternity. It always contains just exactly what one wants to know about. Your descriptions of new developments, important electrical industries, and, in fact, each entire issue is always timely, valuable and highly interesting.

JOSEPH SACHS.
New York City.

A REFRESHING CHANGE.

I noted with pleasure the article so fully describing and illustrating the works of the New York Edison Company, in the issue of "The Electrical Engineer" for January 8th. You are to be commended for this admirable article. I was especially pleased to find the full description of stations and apparatus supplemented by details of operation. This even eclipses a former account of the Chicago Edison station. I trust you may favor your readers with more matter of this character. It is a refreshing change from the usual descriptions of electrical plants. Wishing you the continued success you deserve,

W. M. STINE,
Department of Electricity, Armour Institute,

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS, ISSUED MARCH 3, 1896.

Alarms and Signals:—

DISTRICT ALARM SYSTEM. M. E. Barrett, Chicago, Ill., 555,491. Filed April 16, 1895.

The transmitting instruments are arranged in circuit in such a manner that the opening of the circuit need not block the transmission of signals.

ELECTRICAL RAILWAY SIGNAL. W. Fiedler, Charlottenburg, Germany, 555,601. Filed Aug. 25, 1894.

Has for its object to dispense with traction wires for operating semaphore signals and to provide an operating apparatus which may be attached to existing signals.

SIGNALING CIRCUIT. J. J. O'Connell, Chicago, Ill., 555,707. Filed Dec. 23, 1895.

Comprises a system in which the signal sending appliances at one station when actuated remain in their working position, effectuating the continuous giving of the signal at the other station until the attendant at the other station takes proper action in response thereto.

Conductors, Conduits and Insulators:—

METHOD OF AND APPARATUS FOR PREPARING AND TREATING ELECTRICAL CONDUCTORS. C. E. Carpenter, Bridgeport, Conn., 555,895. Filed Nov. 16, 1893.

Consists in first shaping the conductor, then placing the same upon a supporting body, then heating the conductor until it becomes limp or inelastic, and then allowing it to cool.

Dynamos and Motors:—

DYNAMO ELECTRIC MACHINE AND ELECTRIC MOTOR. G. A. Welles, Jr., New York, 555,544. Filed April 12, 1895.

A single coil multipolar magnet, provided with arms radiating from core at either side of its coil, and terminating with U-shaped pole pieces alternating in sign.

MONOCYCLIC GENERATOR. E. Thomson, Swampscott, Mass., 555,590. Filed March 29, 1895.

A main armature generating single phase alternating current, an auxiliary armature, comprising a winding upon a separate core from the main armature, but mechanically connected with the main armature and generating an electro-motive force of displaced phase, and a connection between the teaser-armature and the main armature.

ARMATURE FOR DYNAMOS AND MOTORS. G. A. Welles, Jr., New York, 555,628. Filed April 12, 1895.

Built up in segmental sections and provided with coils so placed thereon that spaces are left on the outer periphery thereof, in combination with a circular retaining ring.

CORE AND COIL FOR DYNAMO ELECTRIC MACHINES. A. L. Cushman, Concord, N. H., 555,850. Filed Aug. 29, 1894.

An inductive core provided with grooves or recesses of equal width from top to bottom, coils or windings composed of insulated wire all of equal length, and suitable end caps for inclosing the coils or windings, each having an internally, projecting flange or ring adapted to support said coils.

ARMATURE FOR INDUCTION MOTORS. A. L. Cushman, Concord, N. H., 555,851. Filed Aug. 13, 1894.

An armature having the short-circuit multiple windings and short-circuit coils closed in series, arranged in such numbers and relation one to another as to cause unsymmetrical polarities.

ARMATURE FOR INDUCTION MOTORS. A. L. Cushman, Concord, N. H., 555,899. Filed June 24, 1895.

An armature winding composed of coils, each of which forms a short circuit rectangle, the coils being of such length as will cause each set of successive coils to reach by or overlap each other.

Lamps and Appurtenances:—

ELECTRIC ARC LAMP. R. Schefbauer, Hoboken, N. J., 555,621. Filed Aug. 8, 1895.

Mechanism relating to an inclined carbon arc lamp.

ELECTRIC ARC LAMP. E. Lavens, New York, 555,706. Filed May 23, 1895.

Its object is to simplify the construction of arc lamps by decreasing the number of operative parts.

ELECTRIC ARC LAMP. T. E. Adams, Cleveland, O., 555,841. Filed June 6, 1895.

Relates to the contact or gripping surfaces of friction clutches for electric arc lamps.

ELECTRIC ARC LAMP. T. E. Adams, Cleveland, O., 555,891. Filed Oct. 10, 1895.

The combination with a separating magnet and the carbons, of a pivoted lever connected with the carbons, and a flat spring secured at one end to the pivoted end of the lever and connected at the other end to the armature of the magnet.

Measurement:—

ELECTRIC METER. G. A. J. Telge, Oldenburg, Germany, 555,589. Filed Feb. 21, 1895.

The pendulum of a clock movement is caused, by means of a pivoted or rocking beam under the influence of a solenoid core, to undergo variations in length, position or tension, so that the difference between the times indicated by the clocks will give a direct measure of the quantity of electricity that has passed through the solenoid.

ELECTRICAL MEASURING INSTRUMENT. A. H. Hoyt, Penacook, N. H., 555,702. Filed June 10, 1895.

The combination with a spring supported armature, of a pointer adapted to travel over a suitably calibrated scale, and a multiplying connection between said armature and pointer.

Miscellaneous:—

METHOD OF CONVERTING POTENTIAL ENERGY OF CARBON INTO ELECTRICAL ENERGY. W. W. Jacques, Newton, Mass., 555,511. Filed June 5, 1895.

See page 261.

ELECTROMAGNET FOR SEPARATING METALS. H. H. Whitacre and A. C. Wolfe, Wellsville, O., 555,546. Filed March 1, 1895.

Combination of a series of magnets radially disposed about and parallel with a central axis.

ENGRAVING MACHINE. B. S. Molyneux, Minneapolis, Minn., 555,581. Filed May 1, 1894.

The combination with a graver or drill, of an electric motor, with the motor armature and the drill on a common shaft which is free for sliding movement in fixed bearings.

METHOD OF AND APPARATUS FOR MAGNETIC SEPARATION. J. P. Wetherill, South Bethlehem, Pa., 555,792. Filed Feb. 10, 1896.

An electromagnet having a pole piece tapering toward its free end and having a core substantially equal in breadth to the pole piece, and a conveyor passing around the pole piece for introducing the ore into the magnetic field and withdrawing the attracted material from said field.

SEPARATION OF FRANKLINITE ORE AND METALLURGY THEREOF. J. P. Wetherill, South Bethlehem, Pa., 555,793. Filed Feb. 10, 1896.

Similar to above.

MAGNETIC SEPARATOR. J. P. Wetherill, South Bethlehem, Pa., 555,794. Filed Feb. 10, 1896.

Similar to above.

ELECTRIC COAL CUTTER. I. E. Storey, Boulder, Colo., 555,832. Filed Dec. 20, 1890.

The combination with a motor and its shaft, of a counter shaft passing between the field magnet coils, bevel pinions carried by the counter shaft, a bevel gear with which said pinions are adapted to engage a cutting chain driven by said gear and a feeding mechanism driven by said counter shaft.

TIMING APPARATUS. G. F. Brackett, Jersey City, N. J., 555,847. Filed March 14, 1895.

The combination with a time movement, and time movement stop mechanism controlled by the stop mechanism and means for actuating the stop mechanism.

Railways and Appliances:—

CLOSED CONDUIT ELECTRIC RAILWAY. C. Anderson, Leeds, England, 555,487. Filed March 1, 1894.

The conductor is laid in a closed conduit; the rails are used to complete the circuit.

CLOSED CONDUIT ELECTRIC RAILWAY. C. Anderson, Leeds, England, 555,488. Filed Feb. 13, 1895.

Employs vertically movable contact pegs and means to operate same by approaching car.

ELECTRIC RAILWAY. R. M. Hunter, Philadelphia, Pa., 555,500. Filed June 21, 1894.

Has for its object the substantial elimination of the tracks and earth as the return conductor, and using the tracks essentially as a bridging media between the positive and return conductors of the electric railway.

MOTOR HANGER FOR ELECTRICALLY PROPELLED CARS. E. Peckham, New York, 555,529. Filed June 11, 1895.

The combination with an electric motor pivotally connected at one end to the axle of the truck, of longitudinal motor hangers, pivotally connected between their ends to the sides of the motor and supported at each end from the frame of the truck.

TROLLEY PROTECTOR FOR FIREMEN. J. P. Barrett, Chicago, Ill., 555,534. Filed Dec. 13, 1895.

A support which makes contact between the trolley wire and track, short circuits them and blows the fuse at the station.

TROLLEY POLE AND CONNECTION. C. H. Finson, Pittsfield, Me., 555,571. Filed July 20, 1895.

Has for its object to prevent the trolley, when it has accidentally left the wire, from flying above said wire.

SAFETY APPLIANCE FOR ELECTRIC BRAKES. W. B. Potter, Schenectady, N. Y., 555,585. Filed April 22, 1895.

Comprises a braking switch, a circuit, including brake magnets and a source of electro-motive force, a solenoid having its core attached to and controlling the braking switch, and means for actuating the solenoid by excess of current in the circuit.

TROLLEY HEAD. W. H. Carr, Bath, Me., 555,764. Filed Oct. 15, 1895.

The frame supporting the wheel is pivoted at nearly a right angle to the arm, insuring ease in turning curves.

ELECTRIC PROPULSION SYSTEM FOR CARS. G. H. Melotte, Marsh, Pa., 555,783. Filed Aug. 15, 1895.

A trolley wire so strung as to cross the path of the trolley at definite intervals in alternate directions and a trolley of such a length as to always be in contact with one or more of such crossings.

ELECTRIC RAILWAY SYSTEM. A. J. Beltzel, Boiling Springs, Pa., 555,800. Filed April 15, 1895.

A series of switches suitably connected, contact points extending therefrom, levers for making and breaking current, and a rod connected with the lever and protruding into the grooves of the rails and operated by suitable throws on the car.

BOND OR CONNECTOR FOR ELECTRIC RAILWAYS OR OTHER ELECTRIC CONDUCTORS. A. Bournonville and J. J. Zimmele, Philadelphia, Pa., 555,846. Filed Sept. 20, 1895.

A bar having a body half round or segmental in cross-section and an end reversed on itself forming a divided head which is adapted to be spread apart.

ELECTRIC RAILWAY BRAKE. J. C. Henry, Westfield, N. J., 555,862. Filed July 3, 1895.

Employs a combined dynamo and magnetic clutch on one axle of each car, and means for operating a drum normally loose on the axle, to wind up the brake chain.

Regulation:—

CONTROLLING MECHANISM FOR ELECTRIC MOTORS. L. T. Gibbs, Milwaukee, Wis., 555,503. Filed Jan. 2, 1896.

A lever adapted to gradually cut out of the armature circuit a series of resistances in starting the motor, and an automatic safety switch.

Telegraphs:—

FAC-SIMILE TELEGRAPHY. A. W. Storm, Ramsey, N. J., 555,626. Filed Sept. 11, 1895.

A message having a design partly of non-conducting and partly of conducting substance thereon, in combination with a telegraphic transmitter, having a circuit closer with adjacent contact points.

Telephones:—

TELEPHONE CALL REGISTER. H. Hempel, Berlin, Germany, 555,645. Filed April 9, 1895.

Means of control or indication of use of the telephone by subscribers is obtained so far as the subscriber is concerned, while the use of it on the part of the summoned subscriber is not controlled.

PARTY TELEPHONE LINE APPARATUS. A. S. Hibbard, Chicago, Ill., 555,725. Filed Sept. 16, 1895.

Means whereby a number of telephone sets may be connected with a party line and selective signals sent over the line to ring with bell at any one of the sub-stations without affecting the remaining bells. Uses polarized signal bells.

LEGAL NOTES.

INJUNCTIONS GRANTED AGAINST MANUFACTRERS OF TROLLEY STANDS ON THE VAN DEPOELE UNDER RUNNING TROLLEY PATENT.—THE GENERAL ELECTRIC CO. VS. BILLINGS & SPENCER AND KELSEY ELECTRIC RAILWAY SPECIALTY CO.

An interesting and important decision has just been rendered by Judge Townsend, of the United States Circuit Court for the District of Connecticut, upon the Van Depoele patent No. 495,443, for the under-running electric railway trolley system.

A few months ago Judge Townsend rendered a decision sustaining the validity of the patent upon final hearing in a suit against the Winchester Avenue Railroad Company, of New Haven. Shortly thereafter further infringement suits were brought in Connecticut against the Billings & Spencer Company, of Hartford, and the Kelsey Electric Railway Specialty Company, of New Haven. Judge Townsend has just decided these suits in favor of the Van Depoele patent, and granted motions for preliminary injunctions after full argument on both sides.

The decision is especially important because the court holds that the supply of essential or characteristic parts of the trolley system is a contributory infringement, and will be enjoined by the courts, even though the defendants may not supply or use the patented combination or system in its entirety. The court further held that an unlicensed maker of trolley bases could not be permitted to supply such bases even to railroads which had been originally fully equipped by the General Electric Company.

From the court's opinion, it appears that the defendants in this instance made and sold trolley stands or bases; they urged that such bases were not covered in detail by the patent as a separate article of manufacture and further contended that they at least might be lawfully sold to or used by purchasers to repair or replace parts of original equipments furnished by the Thomson-Houston and General Electric Companies, under the authority of the Van Depoele patent. But the court held that neither of these things could be lawfully done. First, because the supply of parts of the patentee's system is in reality intentionally aiding other parties in the unlawful making, selling or using of the patented system as a whole. Second, because the replacement of a lawful by an unlawful trolley base or stand is not a legitimate repair, but a reconstruction of the combination patented. In other words, infringement and injunction cannot be avoided by making up a complete system of parts gathered together from various sources, but on the contrary, all parties who contribute towards the infringement of the entire combination by supplying necessary and durable parts thereof, are themselves infringers, and subject to injunction.

A large number of prior decisions were referred to by the court, where rulings of a similar nature have been made, which establish the general doctrine that any supply of parts amounting to the intentional promotion of the act of infringement by others will be restrained by injunction, and that the full scope of the Van Depoele patent cannot be avoided in this way, even if the parts so supplied or used are not claimed by themselves alone as specific and separate features of the patented invention.

THE BERGMANN SOCKET PATENT NOT CONTROLLING—EDISON ELECTRIC LIGHT COMPANY vs. ELECTRIC ENGINEERING AND SUPPLY COMPANY OF SYRACUSE.—OPINION OF JUDGE COXE.

The patent, No. 311,100, on which this action is founded, was granted to Sigmund Bergmann January 20, 1885, for improvements in sockets for incandescent electric lamps. The improvements relate to sockets designed to receive lamps whose terminals are a screw-fastened ring and a plate on the base of the lamp. The object was to provide a compact socket, having few parts, a small amount of insulating material and a simple circuit controller. * * *

The claims in dispute were:

1. In a socket for an electric lamp, the combination of two circuit terminals, one a sleeve adapted to make contact with the band or ring terminal, the other a spring movable into and out of contact with the bottom terminal of the lamp, substantially as set forth.

3. In a socket for an electric lamp, the combination, with a disk of insulating material, of a contact-sleeve for making contact with the band or ring terminal of the lamp, a contact-piece for making contact with the bottom terminal of the lamp, and two terminals for the circuit-wires leading to the socket, all said socket contacts and terminals being carried by the said insulating-disk, substantially as set forth.

4. In a socket for an electric lamp having two terminals for making connection with corresponding lamp materials, the combination of a metal-supporting portion and a disk of insulating material carried thereby, and carrying all the terminals and contacts of the socket, substantially as set forth.

9. The combination, with a contact-spring, substantially of the form described, of a separate turning-key bearing against said spring, whereby it may be forced upward to make contact, substantially as set forth.

13. In a socket for electric lamps, the insulating body which supports the terminals or connections, formed of non-combustible material, substantially as set forth.

It is unnecessary to discuss at length the many questions presented by the elaborate record and briefs, for the reason that when subjected to analysis it must be found that Bergmann's claim to invention rests upon two narrow foundations; first, the character of the insulation, and, second, the form of the circuit controller or key. Unless invention can be found in these two features it can be found nowhere.

The use of combustible insulating material in this art was very old. Soapstone, glass and plaster of paris had been used and porcelain had been suggested by Gordon in 1880. * * *

An examination of this record must convince the impartial reader that the use of non-combustible insulating material in this analogous situation was not new with Bergmann, and that its advantages were recognized by a number of electricians long prior to the date of his patent. If the disk claims are construed broadly as covering all kinds of non-combustible insulating materials, they are clearly because non-combustible material had been used in similar combinations, and if these claims are limited to lava, the defendant does not infringe, for the reason that it uses porcelain and not lava. * *

Circuit breakers in the sockets of incandescent lamps were old at the date of the patent in suit. One of these was before the court in Schuyler Electrical Company versus this defendant, 62 Fed. Rep., 588; 66 Fed. Rep., 313. It was there held that as early as 1881 a claim for such a device must be limited to the precise mechanism shown and described. Since that date, and prior to the date of Bergmann's application, key circuit controllers operating in a great variety of ways were devised by a number of electricians, including Bergmann himself. It is not, of course, pretended that a circuit controller located in a lamp socket was new with Bergmann. All that is claimed for his key is that it is simpler and better than those which preceded it. The specification says: "The circuit controller making and breaking circuit upon the lamp tips employs fewer parts and is simpler in construction than any heretofore used." In short, as to both branches of the controversy, it is perfectly obvious that Bergmann is in no sense a pioneer. Unquestionably he produced a simple, compact, durable and efficient socket, but the art did not begin with him, and it ought not to be held to end with him. He has originated no new principle of operation; he has produced no new result. He improved upon existing structures. Other inventors should be permitted to do the same. With the exception of claim 13, which, it would seem, is too broad to be upheld upon any rational theory, the claims in question may be sustained if confined to the precise structures described and shown. They cannot, however, be held to suppress improvements which differ from Bergmann as essentially as he differs from the prior art. * * *

The court then points out the differences between the defendant's socket, made under the Hinds, 1891, patent, and that of Bergmann, and continues:

"If the broad construction contended for by the complainant were permissible the defendant would, unquestionably, infringe, but with the limited construction made necessary by the prior art and by the language of the patent it is equally manifest that the defendant does not infringe. Upon the whole case the court is satisfied that Bergmann was simply an improver upon the prior art in matters of detail only, and that he must be confined strictly to what he had described and shown." * * *

The bill is dismissed.

C. S. Mitchell and R. N. Dyer, for the complainant; Alfred Wilkinson, for the defendant.

APPROVING THE NEW YORK UNDERGROUND.

The Commissioners, F. R. Coudert, G. Sherman, and W. H. Gelshenen, who were appointed by the New York Supreme Court to determine by public hearings the advisability of the underground road proposed by the Rapid Transit Commission, have filed a report approving the plan.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS, of Scranton, Pa., are now issuing a handsome monthly paper, called "Home Study," for students in the industrial sciences and others who need fuller knowledge of arithmetic, geometry, trigonometry, physics and drawing, in order to enable them to derive the best results from their study and reading. The paper is well put together and full of helpful, systematic information.

SOCIETY AND CLUB NOTES.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the meeting of the Institute, February 26, the report of the Committee on Incorporation was read, and a resolution empowering the council to proceed with the work of incorporation was unanimously adopted.

The discussion of Mr. Sprague's paper on "Electric Elevators" was then taken up, in accordance with a vote of the meeting, January 22, when lack of time prevented some members from participating. The discussion was reopened by Dr. Hutchinson, who presented the results of actual tests made. He was followed by Messrs. Geo. Hill, R. P. Bolton, H. Ward Leonard and others.

At the meeting of the council, in the afternoon, the following associate members were elected: Daniel Adamson, manager John Adamson & Co., Hyde, Cheshire, England; Isaac F. Badeau, assistant to the engineer, Metropolitan Telephone and Telegraph Company, residence 213 West One Hundred and Twenty-first street, New York City; Samuel D. Collett, engineer construction department Metropolitan Telephone and Telegraph Company, 18 Cortlandt street, New York City, residence 15 Cranberry street, Brooklyn, N. Y.; Edward P. Decker, electrical engineer, Metropolitan Telephone and Telegraph Company, 18 Cortlandt street, New York City, residence Van Pelt Manor, S. I.; Samuel L. Foster, electrical engineer, Market Street Railway Company, 19 Hobart Building, residence 839 Twenty-fourth street, San Francisco, Cal.; Eugene E. Griffes, senior partner, firm of Griffes & Sumner, 307 South Main street, Los Angeles, Cal.; Ralph L. Montague, chief of electrical department, the Gold Dredging Company, Bannack, Mont.; Edwin S. Reid, superintendent of construction, Standard Underground Cable Company, 18 Times Building, New York City, residence 116 West Eleventh street; E. C. Sharpe, consulting electrical engineer, 20 Potomac Block, Los Angeles, Cal.; Edward Sullivan, United Electric Light and Power Company, 108 Fulton street, New York City, residence 337 West Eighteenth street.

The following associate members were transferred to full membership upon recommendation of the Board of Examiners: Geo. D. Shepardson, professor of electrical engineering, University of Minnesota, Minneapolis, Minn; Henry A. Sinclair, electrical engineer, the Tucker Electric Company, New York City; Paul N. Nunn, consulting engineer, San Miguel Consolidated Gold Mining Company, Telluride, Colo.; Geo. H. Winslow, electrical engineer, 700 Lewis Block, Pittsburg, Pa.; Wm. D. Gharky, superintendent underground cable construction and maintenance, Philadelphia Traction Company, Philadelphia, Pa.; Walter C. Fish, manager Lynn Works, General Electric Company, Lynn, Mass.

MEETING OF THE ELECTRICAL TRADES ASSOCIATION.

With the object of forming in New York an organization like that in Philadelphia, for the better protection of trade and credit, Messrs. Bournonville, of A. F. Moore; Wilkins, of the Partrick & Carter Company, and Trump, of the Novelty Electric Company, met a number of representatives of the electrical industries at the Astor House on March 4. The following local concerns were present, as thus represented:

New York Insulated Wire Company, R. E. Gallaher; American Electrical Works, Providence, R. I., E. F. Phillips and P. C. Ackerman; "Electrical Review," New York, C. W. Price; Okonite Company, New York, G. T. Manson; the E. S. Greeley & Co., New York, T. J. Smith; Safety Insulated Wire and Cable Company, New York, A. P. Eckert; Manhattan Electrical Supply Company, New York, J. J. Gorman; Union Porcelain Works, Brooklyn, C. H. L. Smith; "The Electrical Engineer," T. C. Martin and W. F. Hanks; J. J. Jones & Son, New York, E. A. Lowe; W. R. Ostrander & Co., New York, J. B. Peck; Interior Conduit and Insulation Company, New York, C. P. Geddes; Western Electric Company, New York, E. R. Gilmour; "Electrical World," New York, W. J. Johnston; J. A. Roebling Sons Company, J. P. Marshall; "Engineering Magazine," Chicago, Ill., F. DeLand; Bushwick Glass and Carbon Company, Brooklyn, M. B. Downes.

Mr. W. J. Johnston was made chairman, and Mr. A. P. Eckert secretary. The chair appointed the following committee to look into the advisability of forming the New York Electrical Trade Association: Messrs. Gallaher, Price, Geddes, Gilmour and Smith.

Letters were received from Messrs. Benedict & Burnham, represented by W. A. Hungerford; the "Western Electrician," represented by W. F. Osborn; Ansonia Brass and Copper Company, represented by A. A. Cowles.

The India-Rubber and Gutta-Percha Insulating Company have signified their intention of joining the association. The association will call a meeting for this week, the exact day to be named later by Mr. R. E. Gallaher, when definite action is looked for.

HISTORICAL AND LOAN EXHIBIT AT THE ELECTRICAL EXPOSITION.

In connection with the electrical exposition, to be held in this city next May, arrangements have been made for a very interesting historical and loan exhibit, to which it is intended to devote considerable space on the main floor. A committee, composed of T. C. Martin, Dr. Park Benjamin and E. L. Morse, has been asked to take the superintendence of this exhibit, and, having consented to do so, is already at work. Dr. Benjamin has one of the very finest libraries in the world of early books on electricity, and these will be shown in cases, arranged chronologically with explanatory notes, portraits, autographs, etc. Mr. Morse, as the son of Professor S. F. B. Morse, is the possessor of an invaluable collection of telegraphic relics, curios, documents, etc., including his father's notebooks and sketches, all of which will be shown. Mr. Martin, besides owning many objects of interest connected with the early days of electricity, has secured from Mr. Tesla, Professor Elihu Thomson, Mr. Edison, Mr. Edward Weston, Mr. Stieringer and others no less well known the loan of early and interesting apparatus, constituting a personal exhibit from each inventor of the most interesting and instructive nature.

NEW YORK ELECTRICAL SOCIETY.

Mr. George H. Guy, the Secretary of the above Society, has just issued a neat 8-page brochure, detailing its objects and giving a list of some of the more important papers that have been read before it during the period since 1887. It is a remarkable record of good work, and the society was never more active and useful than to-day. It is the oldest body of the kind in America, having been founded in 1881. We earnestly recommend young men in this vicinity, interested in electricity, to join the society, as a means of instruction and of intellectual and social enjoyment.

MR. EDISON AT THE ELECTRICAL EXPOSITION.

The public will have an opportunity to witness the new method of photographing through solids at the electrical exposition, to be held in New York City in May, in connection with the nineteenth convention of the National Electric Light Association.

Mr. Edison has succeeded in making cathodographs through eight inches of yellow pine, and anticipates no trouble whatever in making these instantaneous shadow pictures. He has generously offered to send to the exposition his most powerful and improved apparatus for making shadowgraphs, and his own corps of laboratory assistants to operate the same. This will be freely open to public examination and use.

Mr. Edison will also send to the exposition his large collection of experimental apparatus and designs pertaining to his early work on his many inventions, much of which has never yet been shown to the public.

TEXAS STREET RAILWAY ASSOCIATION.

The Texas Street Railway Association will hold its second annual convention at Galveston on March 18 next. The officers are W. H. Sinclair, President, Galveston, Texas, and C. L. Wakefield, Secretary, Dallas, Texas. These, with W. H. Weiss, of San Antonio; George B. Hendricks, of Fort Worth, and C. A. McKinney, of Houston, represent the directory. Supply men will be welcome, and space will be provided for them for exhibits, if they desire it. Applications should be made to J. K. Urie, care Galveston City Railway Company, Galveston, Texas.

A FRENCH MEMORIAL TO FRANKLIN.

A special cable dispatch from Paris of March 8 says: Several hundred persons to-day attended the unveiling of a memorial tablet that has been erected on the site of the villa at Passy occupied by Benjamin Franklin from 1777 to 1785. It was at this villa that Franklin erected his first lightning conductor in France. The dramatist, M. Manuel, President of the Passy Historical Society, presented the tablet. M. Faye, a member of the French Academy, spoke of Franklin's scientific researches.

J. B. Eustis, the American Ambassador, acknowledged the gift of the tablet. M. Roujon, Director of the Society of Fine Arts; Moncure Conway, Henry Bacon, the artist; Meredith Read, and many ladies were present at the ceremony.

Trade Notes and Novelties

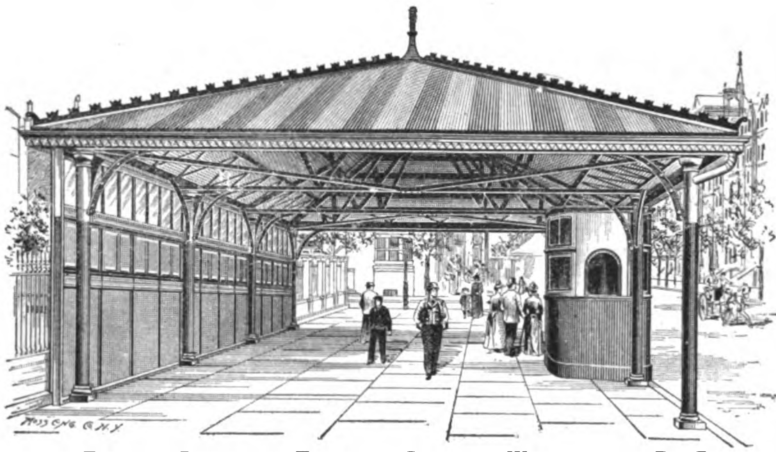
AND MECHANICAL DEPARTMENT.

PASSENGER TRANSFER STATION AT WASHINGTON, D. C.

Consolidation is the order of the day. The public are beginning to understand that monopoly in street railway traffic in small cities is not the green-eyed monster it has been painted. A passenger who can go from one part of the city to another, transferring sometimes twice and three times in the trip for one fare, does not look at the monopoly of the railroad company as he formerly did when it cost him a new fare every time he changed cars. An important problem, however, for the management to consider is the comfort of passengers at transfer points.

We illustrate on this page a transfer station lately designed and built by the Berlin Iron Bridge Company, of East Berlin, Conn., for the Washington and Georgetown Railway Company at Washington, D. C. The building is located at the head of Pennsylvania avenue, at the right of the front entrance to the Treasury Department. In order to locate the station at this point on property belonging to the United States Government, it was necesary to obtain a special act of Congress before the District Commissioners would allow the building to be put up. The illustration shows a very neat shelter. The building is 20 feet in width—the full width of the sidewalk—and 50 feet in length.

The side adjacent to the Treasury Department, or what would ordinarily be called the side next to the fence, is made of glass and iron so that it can be removed at pleasure. On the curb side there is a small transfer station made of sufficient size to accommodate one person, and at the same time a small stove, to furnish heat in severe cold weather. The building is open at all other points. The view shows the construction of the building so well that little need be said. The only obstruction to ordinary traffic is the small house or transfer station, and this is located so near the curb that it practically amounts to no obstruction at all. There is not a particle of woodwork used in the building, the construction being entirely of iron and glass, so that there is no fire risk whatever. The roof is covered with the Berlin Iron Bridge Company's patent anti-condensation corrugated iron, with corner cresting, which with the round supporting columns with ornamental caps and bases, gives the building a very ornageneral surrounding, and at the same time forms a very comfortable and convenient shelter for transfer passengers.



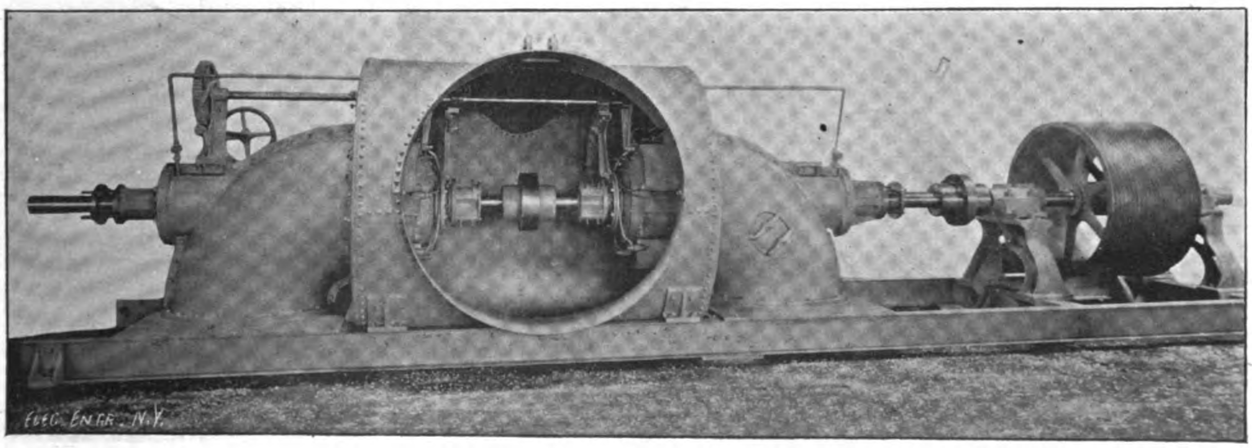
TROLLEY PASSENGER TRANSFER STATION, WASHINGTON, D. C.

NEW AMERICAN TURBINES FOR THE MARQUETTE, MICH., CITY LIGHT PLANT.

The accompanying engraving illustrates the water wheels and flume which were recently installed in the City of Marquette, Mich., in its new city lighting plant. The outfit was designed and manufactured by the Dayton (O.) Globe Iron Works Company, and consists of a pair of 22-inch special new American turbines to operate under 80-foot head and to develope 900 horse-power. The wheels are placed in a horizontal flume, made with castiron heads, with wrought steel shell. The flume is mounted on steel I-beams and cross girders, which are placed on solid masonry. The water is conducted to the turbines in a wrought steel supply pipe 6 feet in diameter, and is discharged from the wheels through the castiron quarter turn at each end of the flume and steel draft tubes into the tail water. The feeder pipe is furnished with a revolving valve to shut off the water when desired. This feature, however, is not shown in the illustration.

The power is transmitted from the wheels to a countershaft by means of a gearing of twenty ropes 1⅓ inches in diameter, which travel at a speed of 7,000 feet per minute, and from thence the power is transmitted to the dynamos The driving sheave is shown on the water wheel shaft.

The whole power plant is first class in every detail, designed and constructed to give perfect satisfaction and to stand



DOUBLE TURBINE, BUILT BY THE DAYTON, O., GLOBE IRON WORKS CO. FOR THE MARQUETTE, MICH., CITY LIGHTING PLANT.

the immense pressure due to a head of 80 feet. The manufacturers feel justly proud of this and other plants which they have constructed to meet the requirements of these very high heads.

We may add that the entire power-plant was furnished by the Dayton Globe Iron Works Company.

THE LITTLE GIANT TRACK CLEANER AND RUSSELL SNOW PLOW.

ONE of the most annoying things which electric railroads have to contend with in winter is snow and sleet on the tracks, and at other times, as well, dirt is frequently a bar to quick traffic. It is not an easy matter to design a track-cleaner which shall be thoroughly adapted to its work and at the same time operate smoothly, but an excellent example filling both these requirements is the Little Giant Track Cleaner, built by the W. E. Austin Manufacturing Company, of Norway, Me., and illustrated in Fig. 1.

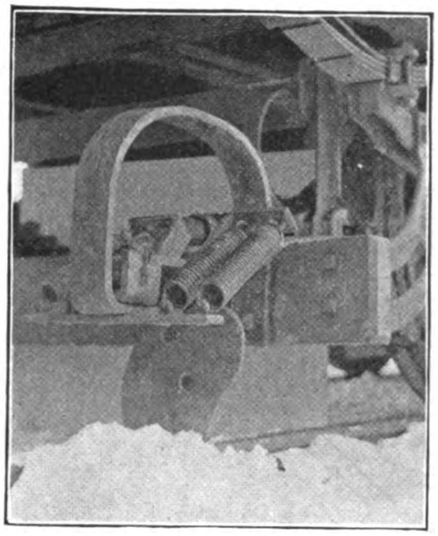


FIG. 1.—THE LITTLE GIANT TRACK CLEANER.

One of the essential features of this apparatus is the constant pressure exerted by the scraper on the rail. The arrangement is such also that one or both scrapers can be run, so that if one rail is salted, the scraper over the opposite rail alone need be used.

As the scraper is attached to the truck and not to the body of the car, it makes no difference how much the car oscillates or how rough the track is. In the case of low rails, one or two inches below the roadbed, the narrow blade of the scraper always finds the track.

Fig. 2 illustrates a cheap snow plow designed and constructed by Mr. F. B. Russell, and in use on the electric railroad at Norway, Me., during the present severe winter. The whole apparatus weighs only 2½ tons and requires only one man to operate it. Its cost did not exceed $250. The scraper at the rear of the plow is another application of the track-cleaner shown in Fig. 1.

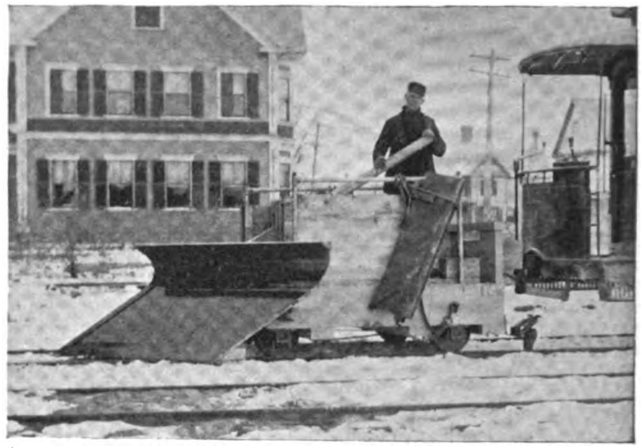
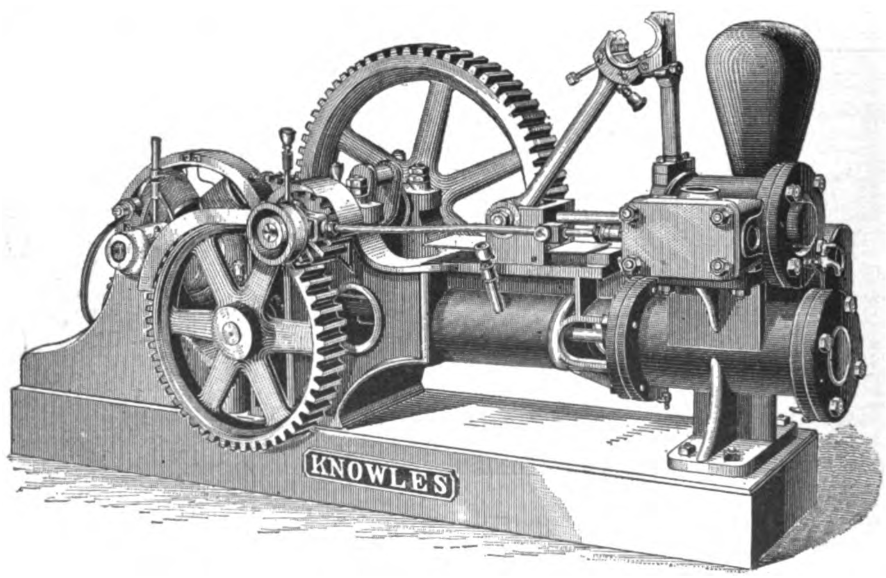


FIG. 2.—THE LEE SNOW PLOW.

KNOWLES ELECTRIC POWER PUMPS.

The special catalogue of electric power pumps of the Knowles Steam Pump Works, 93 Liberty street, New York, with offices in Boston, Chicago and London, will be perused with much satisfaction by the trade. It is compiled from knowledge of apparatus already built in the shops of the company, and well tested in actual service in many countries. Such types have been selected for description and illustration as are likely to meet the needs of the largest section of buyers and users of pumps by various classes. The pamphlet has been written with great discrimination and intelligence, and is confessedly suggestive rather than arbitrary in its general bearing. Various points on which the two great essentials of pumping machinery, economy and effective work, depend are discussed. It is shown that, starting from the coal pile, a direct acting steam pump of the ordinary commercial type will require a greater coal consumption for a given service than a power pump of similar capacity, electrically operated, in spite of the intermediate efficiency losses in engine, generator and motor.

Another point of weight, which has often to be considered, is the compactness and flexibility of the connecting elements between the pump and its source of power supply. Properly insulated wires may be located in cramped spaces or imbedded in walls, where steam pipes would be entirely out of the



THE KNOWLES COMBINATION STEAM AND ELECTRIC PUMP.

question. Attention is called to many other advantages of electric pumping machinery for architects, waterworks, manufacturing processes and for general purposes. Each and every pump made by the Knowles Steam Pump Works is fully guaranteed.

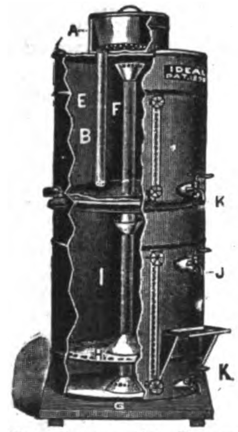
The catalogue, which covers forty-four pages, includes much special and miscellaneous information, more particularly on the various forms of pumps and their successful installation. Specially deserving of notice is the combined steam and electric power pump, which is illustrated in the accompanying engraving. This apparatus is particularly adapted to locations where steam is required only part of the time for heating or power purposes, while pumping must be carried on continuously and electric power is available for use in the intervals. The connecting gear is designed to be quickly connected or disconnected. Cut gears are used throughout, and the crossheads are made with a special take-up for lost motion. Crank shafts are carried in large babbited bearings. The size illustrated has a steam cylinder 4½ inches in diameter, the water cylinders being 3¾ inches and stroke 6 inches.

THE IDEAL IMPROVED STEAM OIL REFINER.

The accompanying engraving illustrates the "Ideal" improved steam oil refiner manufactured by the Purity Oil Filter Manufacturing Company, of 900 Water street, Pittsburg, Pa.

The waste or drip oil is poured into the receiver A, where all coarse articles are arrested by a fine strainer. The oil passes down through pipe B and is discharged in water that has been warmed to a temperature of 150 degrees, by a steam coil that is directly under the water, but not in it. All the heat is by radiation. It is consequently impossible to get the oil or water so hot that it will boil. The waste oil gathered each day is poured in the same way until the chamber E is filled, which will take four or five days; the next day's oil will displace the oil poured in the first by overflowing it into the pipe F passing out in water the second time in chamber I. Here it cools. When the oil rises so that it can be drawn from faucet J it is cold and ready for use again.

A glass gauge is on each chamber that indicates the amount of oil and water that may be in each. The faucets K are for



THE IDEAL OIL FILTER.

regulating the water and for drawing off the sedimentary matter that may accumulate in the refiner. The pan H catches the refuse that may settle on it. It is the full diameter of the shell. This can be withdrawn at any time without drawing off the oil and water, by lifting off the refining chamber E and taking hold of the pipe in the center and pulling up slowly. When out it can be emptied, cleaned in a few minutes, then replaced and allowed to gravitate to its original position, which will not disturb the oil. The refining chamber may then be replaced and steam connections made as before.

The steam coils are ½-inch diameter pipe. Only enough opening in the discharge valve to free the coil of condensation is required. Very little steam is used. It will be seen that the oil has passed through no filtering material or substance. Consequently there is nothing that will require to be renewed except the water.

THE EDISON ELECTRIC COMPANY, New Orleans, La., have increased their power plant by the addition of a 300-horse-power Ball engine, manufactured by the Ball Engine Company, Erie, Pa.

THE FUCHS DRY CELL BATTERY COMPANY has been formed by H. J. Katz, J. V. Falvey, A. Barrington, T. T. Ryan and C. D. Jearance, with a capital stock of $100,000.

LAIRD'S POCKET TOOL.

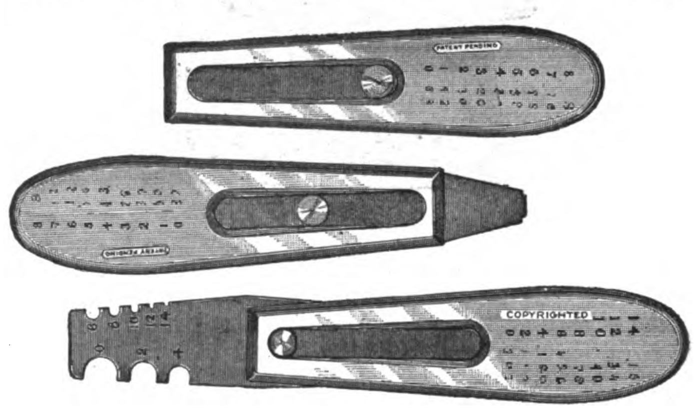
This tool is designed for that class of workmen who need a wire gauge occasionally, who have to carry a screwdriver all the time, and especially those that have wiring calculations to perform.

The wire gauge is the standard Brown & Sharp, ranging from No. 0 to No. 14, a new form of slot being used that reduces the cost of manufacture without impairing the accuracy or utility of the gauge.

The screwdriver is made from the best steel, finely tempered, and is a good emergency or pocket tool from its peculiar shape, which adapts it to anything from the large screws in a main cut-out or switch to the small ones in a key-socket or rosette.

The gauge and screwdriver are on one piece of steel, which is provided with a handle of aluminum, and when the blade is closed the whole outfit is only the size and weight of a common pocketknife, perfectly smooth and neat in appearance.

The flat surfaces of the handle are stamped with figures representing sizes of wires and decimals of ampere feet, and



LAIRD'S ELECTRICIAN'S POCKET TOOL.

by this system, wiring calculations that by the area or resistance method are considerably complicated, are reduced to a single multiplication, and the process is so plain that any one can understand the principles and application. The tables may be learned and then any problem can be solved mentally, something that can hardly be done by any of the present methods.

Through the years of electrical progress, the men that were able to make their own wiring computations have been the exception rather than the rule, and one reason for this is that men who are good mechanics are seldom very handy in the higher mathematics. To provide for this wiring charts by various authors are used and are of great value.

They practically agree in their figures, and electricians that follow them carefully get good results. This method of ampere feet is so arranged that the result agrees with standard rules, and the calculation can be made quicker than it can be looked up in a chart.

These tables are copyright, and are furnished only with the combination pocket tool shown. They are stamped on the handle and are also printed on a neat sheet, together with other valuable information, and the whole will be mailed prepaid to any address for $1 by Laird & Bowers, Montpelier, Vt.

NEW ENGLAND NOTES.

THE BERLIN IRON BRIDGE COMPANY, of East Berlin, Conn., have just completed for the Citizens' Gas Company, at Bridgeport, Conn., two large buildings, one 63 feet wide by 171 feet long, comprising a purifier house, a meter house and a valve house, and the second building, 44 feet wide by 122 feet long, comprising a generator house, a scrubber house and engine room. The side walls are of brick and the roof trusses of steel covered with corrugated iron.

REMINGTON & HENTHORN, of Providence, R. I., have dissolved by mutual consent. The business will be continued by Geo. H. Remington & Co., at 210 Westminster street, where they will attend to securing United States and foreign patents, and prosecute allied branches of their profession.

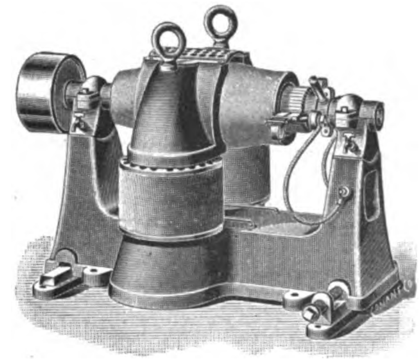
THE AMERICAN ELECTRIC COMPANY has been organized at Kittery, Me., with a capital stock of $20,000 to manufacture electric gas lighters and burners. E. H. Brocke, of Quincy, Mass., is President and W. E. Thomas, of Somerville, Mass., is Treasurer.

THE NEW BATES ELECTRIC MOTOR.

The H. N. Bates Company, of 240 Congress street, Boston, Mass., have been long known in the electrical business as manufacturers of friction clutches and shafting and have now gone into the direct electrical business by getting out a line of electric motors which they are manufacturing themselves, under the superintendence of Mr. L. I. Fletcher, for years associated with the Lowell Electric Light Company, Lowell, Mass.

Particular attention has been given to the production of a medium speed motor of high efficiency, and at the same time the speed is very much less than is common in bi-polar machines.

Every motor is provided with a pair of sliding rails and necessary belt tighteners, and is also fitted with lugs in case it



BATES ELECTRIC MOTOR.

is ever desirable to attach it rigidly to the floor or foundation. The frame of each machine is so built that it can be adapted to 110, 220 and 500 volts, all parts being interchangeable.

All motors above one horse-power are provided with fireproof automatic starting boxes of the latest design so made that if, from any cause, the current is shut off, the switch closes and prevents accident to the armature.

The Bates Company believe that the method of insulation used in both their armature and field coils is so perfect that the danger of burn-outs is reduced to a minimum, especially in the 500 volt type, where the most danger exists. The company is prepared to manufacture at short notice special motors for any speed or voltage.

A DISCUSSION OF THE ARC CARBON QUESTION.

Mr. Hugo Reisinger, of 38 Beaver street, New York, who is the sole importer of the "Electria" Nuernberg carbons for arc lights, as well as other specialties in the carbon line, has just addressed the following argument to central station managers and others interested in the successful operation of arc lights:

The necessity of using the best grade of carbons obtainable wherever not only a really efficient but also an economical arc light service is required, has repeatedly been pointed out by eminent electricians. While in many cases much money is expended for dynamos, arc lamps, etc., in order to insure the above-mentioned advantages, it is difficult to account for the tardiness of some station managers in adopting the best grade of carbons, as a means to get the best return for the money invested in an arc light plant.

Since I introduced the "Electra" High Grade Nuernberg Carbons to the trade, the leading electrical stations have certainly shown their appreciation of their uniform high quality and efficiency by adopting them for their arc lighting, and I am pleased to say that the sales of the "Electra" carbons have been rapidly and continually increasing.

Yet I feel that some station managers have not given enough importance to the carbon question, and that a great many of them are still satisfied with fairly good results in the matter of illumination; and while they think that the price they pay for carbons of lower grades is reasonable, they are under the impression that they are operating economically.

There is no doubt that in many cases the apparent higher price of the best grade of carbons has had the effect of deferring their adoption; but as with machinery and other articles, the first cost should not be the only consideration, quite apart from the fact that all points considered, the best grade of carbon obtainable will always prove the cheapest.

I am convinced that if consumers of arc light carbons will only make a careful test of the carbon they are using against the "Electra" carbon, they will discover that taking the candle-power produced at an expenditure of a certain amount of current, the life, steadiness and dust as important factors, the high grade "Electra" carbons will be by far more economical than any other carbon, foreign or domestic manufactured, or, putting it more plainly, the "Electra" carbon will cost less per given hours of burning than any other carbon which may be listed at a lower price.

There are other carbons in the market for which highest efficiency is claimed, but the many tests to which the "Electra" carbons have been submitted by leading stations, conclusively show that the "Electra" carbon will furnish more light for the same power expended on the lamp, or the same light for less power, that they will burn steadier and produce less dust than any other make, either foreign or domestic, the difference in the efficiency of the "Electra" carbons and other imported carbons being from 10 to 25 per cent.; while the difference in the efficiency between the "Electra" carbons and the best make of domestic carbons, is from 25 to 30 per cent.

While, therefore, the question to be determined by consumers of carbons resolves itself into the relative cost of the carbons, and of the power and fuel they will save, I feel that managers of electric light stations cannot fail to see that my "Electra" carbons are worthy of a trial, and I am sure that after having placed their first order with me, they will use no other carbons thereafter.

In order to enable you to make your own tests of the "Electra" carbons, I shall be very glad to send you samples of any sizes you may desire, free of charge, and also quote you my very best discount on orders for large quantities, or on contracts for yearly requirements.

It would seem that these statements as to the net economy and higher efficiency of a higher-priced article are well worthy consideration, especially as Mr. Reisinger wants every manager to try it for himself.

THE NATIONAL UNDERGROUND CABLE CO.

We learn that the National Underground Cable Company has just received from the Central Union Telephone Company a very large contract for telephone cable for the City of Toledo, the contract covering also the laying, jointing and connecting of the cables, etc.

This is about the largest single telephone cable order given out in the year 1896, and the National Company is to be congratulated upon the receipt of it. This progressive and enterprising company has booked during the week also several large orders for electric light and street railway cables; and is rapidly making itself felt in the line of telegraph cables, for the manufacture of which it has a special department in its factories at Harrison, N. J.

WESTERN NOTES.

W. D. BALL & CO., Consulting Electrical and Mechanical Engineers, 1625 Monadnock Block, Chicago, is the style of the firm succeeding the partnership of Ball & Allen, which has been dissolved, Mr. Allen retiring. The new firm is composed of Mr. W. D. Ball, who has been well known in engineering circles for several years, and Mr. F. E. Drake, formerly the general agent and assistant manager of the Standard Electric Company. The new firm will continue to do consulting and engineering work, Mr. Ball taking the technical end, while Mr. Drake will have the management, caring for the general business.

MR. F. E. DRAKE, who has for years been identified with the Standard Electric Company in the capacity of general agent and assistant manager, has entered the firm of W. D. Ball & Co., Consulting Electrical and Mechanical Engineers, with offices No. 1625 Monadnock Block, Chicago. Mr. Drake's long experience in the commercial field of the industry and his practical knowledge of the requirements of central station, isolated plant and general practice will be of much value to the new firm and its clients.

THE PACKARD MOGUL LAMP is slowly but surely working its way into public favor for large lighting. The Electric Appliance Company, the general Western agents for this specialty, has closed several large contracts for these lamps during the past few months. The Ravenwood platforms and station on the Milwaukee division of the Chicago and Northwestern Railway are lighted by these lamps, and their superiority for this kind of work is plainly apparent. The Electric Appliance Company furnish special shades and street hoods for these lamps, which largely increase their efficiency.

MR. S. F. B. MORSE, of the Marquette Building, Chicago, has returned from a short trip which he recently made to the West, taking in Colorado Springs and the gold region. Mr. Morse, who had not been well for some time, was very much benefited by his little vacation. He also visited Cripple Creek, and although there was quite an exodus of fortune-seekers from Chicago to that region, Mr. Morse was quite pleased to return to Chicago, and his many friends are glad to see him back again.

THE "BABY" KNIFE SWITCH has, it is said, leaped into public favor with about the same rapidity that the new "baby" usually does. The Electric Appliance Company is meeting the demand for this new specialty by carrying a large stock at very low figures. It is furnished in round or square bases in 15 and 25 ampere single and double pole.

THE ELECTRIC SPECIALTIES COMPANY, of 1351 Broadway, Oakland, Cal., report business as excellent, and say that they are three months behind their orders.

Department News Items will be found in advertising pages.

THE
Electrical Engineer.

Vol. XXI. MARCH 18, 1896. No. 411.

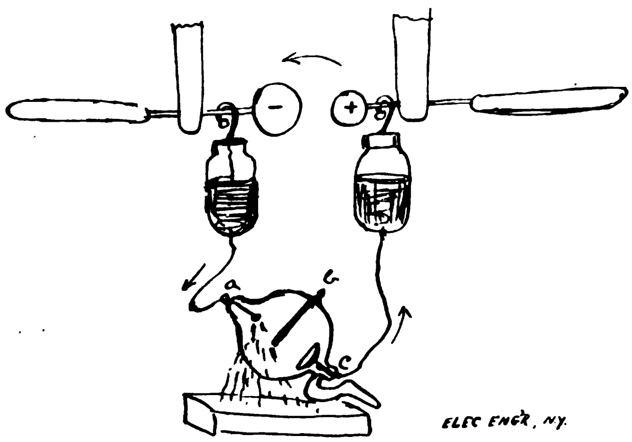
ELECTRIC LIGHTING.

ROENTGEN RAYS FROM THE ANODE TERMINAL.

Elihu Thomson

IN a recent note published in your journal concerning some experiments I made in tracing the Röntgen rays to their source at the metal terminal within the Crookes tube, from which they proceeded in straight lines, this terminal was spoken of as the cathode. I find that Professor Rowland has recently made some experiments which would point to its being the anode which evolves the rays, and on going over the polarities of the Wimshurst machine which I used in my experiments and the direction of the discharges I find that the terminal is indeed the anode from which the rays emanate.

There can be no question about it in the tube which I have used. Before reading Professor Rowland's observations I had been led to doubt its being the cathode which gave the rays and had, in fact, noticed that the terminal on the negative side of the Wimshurst machine is the one which gives the rays. During the discharge of the jars, however, this is not the cathode, but really the anode. These observations of Professor Rowland confirmed by my own would seem to at least point to the fact that the rays are not the same as what are



PROF. ELIHU THOMSON'S ROENTGEN RAY TUBE.

called cathode rays, but that the Röntgen rays are, properly, anode rays.

I have used a fluorescent screen of barium platino-cyanide enclosed within a dark tube with a sight hole at one end, and I find that by having a patch of metal on the side of the Crookes tube, as soon as this metal piece comes between the anode and the screen all fluorescence of the screen ceases, but the slightest displacement either way produces fluorescence on the border of the screen.

This observation shows without doubt that the rays proceed in straight lines from the terminal within the tube, which turns out to be the anode. Experimenting with the Wimshurst machine enables one to be quite positive as to the direction of flow, while with a Ruhmkorff the tendency to oscillatory currents may disturb the observations, and, of course, with high frequency apparatus the anode and cathode are rapidly interchanged.

I enclose a sketch of the arrangement which I have used. I have found that one of the tubes I have is particularly active, and its history is, briefly, this: It was a tube having an aluminum cap as terminal c, an iluminum disc as terminal a, and between the two a platinum sheet mounted on a stem at the side of the bulb, b. It was used on high frequency currents, terminal c being left disconnected for fear of melting down the platinum piece by concentration of the cathode rays or radiant matter of Crookes thereon. During the use the vacuum gradually improved and finally the tube became insulating so that a three-inch spark would not send any discharge through the vacuum. At the same time, the terminal a, or aluminum disc, was melted down into a confused mass. The improvement of the vacuum was doubtless due to the carriage of metallic platinum from terminal b to the sides of the bulb, which absorbed the residual gas. It remained in this condition for a few days.

It was then decided to heat the tube for the purpose, if possible, of driving out the gas which had been taken up by the platinum deposited on the sides of the bulb. This was carefully done, and it was found that the tube became conducting once more and remained so. It, indeed, became, apparently, just in the right condition of exhaustion to give the best results.

I have endeavored to get Röntgen pictures with other Crookes tubes, but none have appeared so satisfactory as this one, and some which are apparently all right for exhibition of the Crookes phenomena give no Röntgen rays. I think it would be desirable in constructing such tubes to seal in a small flat or slightly convex surface of aluminum as an anode and a somewhat extended cathode disc of aluminum, and a third terminal of sheet platinum for the sole purpose of adjusting the vacuum, as by the use of the third terminal, with discharges passing therefrom such an amount of platinum may be deposited on the glass as will carry the vacuum up to the desired point, which is just short of that which makes the vacuum insulating in character.

MR. EDISON'S RESEARCHES ON ROENTGEN RAYS.

BY E. J. HOUSTON AND A. E. KENNELLY.

MR. THOMAS A. EDISON, after numerous experiments on Röntgen rays with about 150 different glass vacuum tubes, has communicated the following information to us for publication:

1. There is no apparent advantage in obtaining very high vacua in the Crookes tubes employed for photographing the shadows of metal gratings. The effect of a very high vacuum is to require a greater voltage to produce fluorescence. The best degree of vacuum is that at which the internal luminescence or striae in the tube just disappears and fluorescence of the walls remains. The Röntgen rays are still produced even when internal striae are observed but are enfeebled.

2. Thin walls are preferable to thick walls in the glass vacuum tubes. A thick wall will fluoresce very brilliantly and become very hot. A thin wall will emit rays having greater photographic power, but may scarcely fluoresce visibly, and will remain very cool. This is proved by a number of experiments, of which the following is one: A tube of the shape roughly indicated in the sketch, Fig. 1, has its walls blown thick in the zone of A C, but thin at B. When this tube is exhausted and excited, the thin part B, which is in the most actively excited area, remains cool and photographically very active, while the glass becomes hot in the ring A C. If B be made thick and A C thin, the glass at B may become melted by the heat, but its photographic power is reduced, although its visible fluorescence is greater. Walls ⅛ inch thick become unmanageable by excessive heat and rapid melting.

3. For any given tube in a given condition of exhaustion, the photographic power of the tube; i. e., the swiftness with which it produces a developable image is roughly proportional to the square of the fluorescent candle-power or total visible fluorescent light given out by the tube.

4. The duration of exposure has been found to be as follows: With the most sensitive plates in an ordinary plate holder having a light vulcanized fiber cover of about 1-32 inch thickness, the time necessary for obtaining a good shadowgraph of a metal grating or grid is less than one second, when the tube

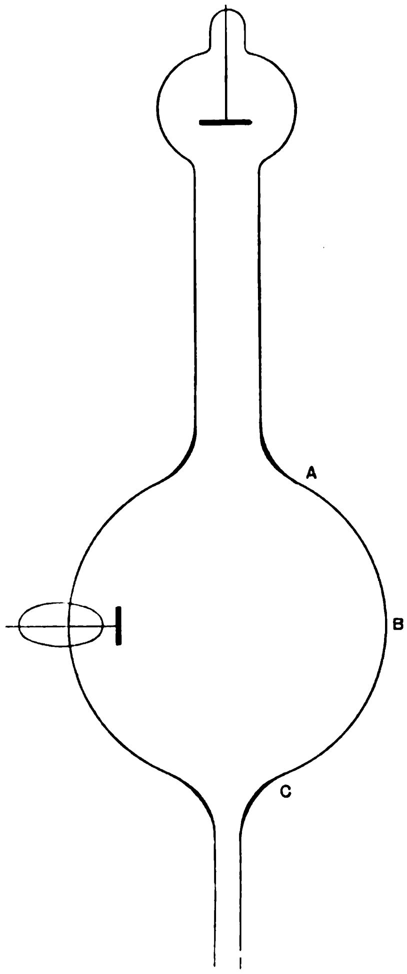


FIG. 1.

is within a quarter of an inch of the grating, and, therefore, about ⅜ inch from the sensitive plate. At two feet distance the time for an equally good shadowgraph is approximately 150 seconds, and at three feet distance the time increases to about 450 seconds. Roughly the duration of exposure may be reckoned as proportional to the square of the distance.

5. Of the photographic plates as ordinarily employed for photographic purposes, the medium rapid plates appear to be the most suitable for Röntgen rays, i. e., to require least duration of exposure. Rapid plates and slow plates appear to be equally unfavorable in regard to sensitiveness for Röntgen rays compared with medium plates. To test this a composite sensitive plate was made from five strips, cut from plates of different photographic sensitiveness, and the shadowgraph of a series of metal bars was taken with the bars at right angles to the strips of the composite plate. For the same exposure and same development the depth of the shadowgraph images produced did not bear any apparent relation to the photographic sensibilities of the strips or their sensitometer numbers. The medium rapid plate gave much the deepest images in every such experiment.

6. The power of a tube having a given degree of exhaustion and disposition of electrodes, increases with the surface area of its fluorescent walls. Thus a large vacuum tube exposing a large total fluorescent surface has a more rapid action on a sensitive plate, i. e., requires less exposure, but will require more voltage and more electric power to excite. On the other hand, for a given distance of the tube from the plate, the image is sharper and less distorted as the tube diminishes in size. Consequently, for a given tube, used without a diaphragm, a fairly great distance and long exposure produced the sharpest photographic effects. A small tube will produce a sharp image at a lesser distance, and for rapid exposure, a very small tube at a very short distance is the best. The smallest tubes experimented with have been about one inch in diameter and with about two inches between electrodes, and with thin glass walls. A small tube requires a small e. m. f., so that tubes can be made to suit almost any induction coil.

7. For a given thickness of glass wall, German glass appears to give better results than lead glass. The German glass employed gives a yellowish fluorescence, while lead glass gives a greenish fluorescence. These glasses phosphoresce visibly for at least ten minutes after the cessation of discharges through the tubes. A particular quality of Scotch boiler water-gauge glass gives apparently equally good photographic results, but does not appreciably phosphoresce after the cessation of the current. The residual phosphorescence has not yet been found to produce a visible photographic image. All phosphorescence yet observed is pale white, whatever the color of the preceding flourescence under excitation.

8. The form of tube arrived at by a gradual process of selection is shown in Fig. 2. The length is about three times

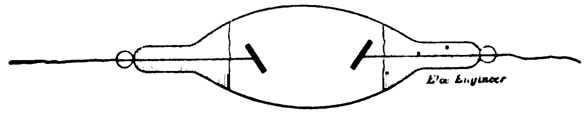


FIG. 2.

the diameter. This tube is made in various sizes. When the glass walls are made thin for producing the best photographic effect a spark is apt to pierce the wall and destroy the vacuum. Partly on this account, tinfoil caps are placed over the extremities of the tube, as indicated by the shaded areas in the sketch. These tinfoil caps are in connection with the electrodes and are cemented to the external surface of the tube by shellac.

9. It was found by repeated trials with many tubes that the fluorescent and photographic power of all the tubes without caps was greatly increased, roughly doubled, in fact, by bringing two metallic discs connected with the respective electrodes to the opposite points, as represented in Fig. 3. The supposition is that the tubes then become at once an ordinary and an electrodeless tube combined. The metallic caps above mentioned were the outcome of these experiments, and not only have all these capped tubes remained unperforated, but their fluorescent and photographic powers have been enchanced by the caps.

The caps serve three purposes: (a) To stop piercing by permitting excessive sparking to escape over the external surface. (b) To increase photographic and fluorescent power. (c) To prevent undue heating of internal electrodes and a consequent change of vacuum.

10. The exciting apparatus consists of a large Ruhmkorff coil capable of giving a 12-inch spark, although such a length of spark is rarely required.

The coil is usually excited from a 120-volt continuous-current circuit through a lamp bank of from eight to twenty 16-candle-power incandescent lamps arranged in parallel, with rapidly rotating wheel interrupter, driven by a small motor. About 400 interruptions are made per second, and the duration of closure in the circuit is twice that of opening. An air blast is directed upon the spark over the periphery of the interrupting wheel, through a fine nozzle. This tends to produce a sudden breaking of the circuit. It has been found that greatly improved results have followed the removal of the usual condenser and the substitution of the airblast. The resulting secondary e. m. f. is almost symmetrical like an alternating e. m.

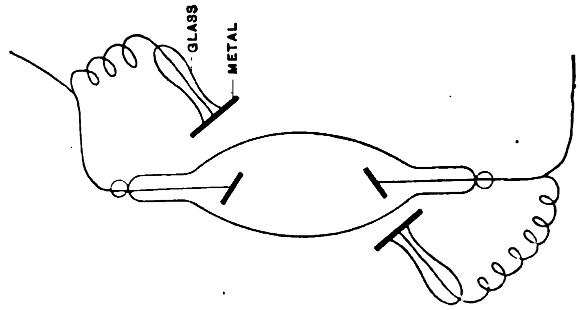


FIG. 3.

f., and the two electrodes in the tube are apparently equally active. The secondary terminals of the induction coil are led directly to the vacuum tube. If the airblast is removed and the condenser substituted, the fluorescent and photographic power of the tube is greatly diminished. The coil is sometimes excited directly through an interrupter from a battery of storage cells.

We believe that these observations of Mr. Edison cannot fail to be valuable to many practical workers with Röntgen rays. We hope to communicate further experimental results at some future time.

DO ORDINARY ILLUMINANTS GIVE OUT X-RAYS?

BY R. K. DUNCAN.

IT has been discovered by several investigators that a Welsbach burner or even an ordinary paraffin flame may be made to affect a covered sensitive plate and to give a shadow picture.

With the object of ascertaining whether this action was due to Röntgen rays, the writer made the following experiments:

1. We first obtained a shadow picture of a coin by placing both coin and plate in a carefully covered plate holder and exposing to the action of a Welsbach burner for seven hours at a distance of five inches. The result was a fairly good shadow picture. It was then apparent that if it took seven hours to obtain a picture from a Welsbach having a glass chimney over the incandescent mantle, it should take much less time if aluminum displaced the glass as a chimney, providing that the effect was due to X-rays, to the action of which aluminum is quite transparent.

2. A second experiment was made precisely similar to the first in time and method, except that aluminum was substituted for glass. After development, no image whatever was found upon the plates.

3. A third experiment similar to the second was tried and verified. This seems to dispose, then, of the idea that the effect is due to X-rays.

4. A fourth experiment was carried out with acetylene as the illuminant. A coin inside a watch glass was placed within a carefully covered plate holder and exposed for two hours to the action of two acetylene flames. After development an image of not only the coin, but the watch glass also, was found upon the plate, while a key wrapped up in aluminum gave nothing whatever.

Now, if the plate holder had been exposed to the action of X-rays from a Crookes tube we should have had a shadow of the watch glass without the case and a picture of the key in the aluminum.

The conclusion, therefore, which the writer draws from these experiments is that shadow pictures obtained from ordinary illuminants are not due to the action of X-rays. A fifth experiment shows that if the plate holder be placed within three inches of the Welsbach, so that it becomes hot, a very well defined shadow may be obtained in forty minutes. One may suspect, therefore, that the entire action is due to heat rays, or leakage of light through the cover of the sensitive plate.

ON RADIANT MATTER.—IV.

BY WILLIAM CROOKES, F. R. S.

IT is of great interest to ascertain whether the law governing the magnetic deflection of the trajectory of radiant matter is the same as has been found to hold good at a lower vacuum. The experiments just described were made with a very high vacuum. Fig. 16 represents a tube with a low vacuum. . When the induction spark is turned on, it passes as a narrow line of violet light joining the two poles. Underneath is a powerful electromagnet. On making contact with the magnet, the line of light dips in the center towards the magnet. On reversing the poles, the line is driven up to the top of the tube. We notice the difference between the two phenomena. Here the action is temporary. The dip takes place under the magnetic influence; the line of discharge then rises and pursues its path to the positive pole. In the high exhaustion, however, after the stream of radiant matter had dipped to the magnet, it did not recover itself, but continued its path in the altered direction.

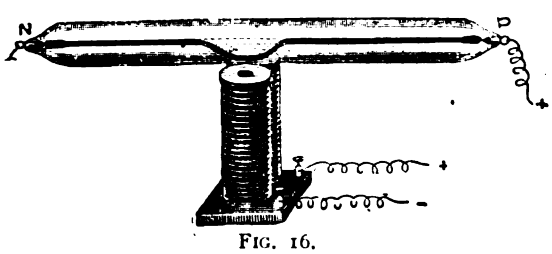


FIG. 16.

By means of the little wheel (Fig. 17) skillfully constructed by Mr. Gimingham, Mr. Crookes was able to show the magnetic deflection in the electric lantern. The negative pole (a, b) is in the form of a very shallow cup. In front of the cup is a mica screen (c, d), wide enough to intercept the radiant matter coming from the negative pole. Behind this screen is a mica wheel (e, f) with a series of vanes, making a sort of paddle wheel. So arranged, the molecular rays from the pole a b will be cut off from the wheel, and will not produce any movement. A magnet, g, was now put over the tube, so as to deflect the stream over or under the obstacle c d, and the result was rapid motion in one or the other direction, according to the way the magnet was turned. The image of the apparatus was thrown on the screen. The spiral lines painted on the wheel showed which way it turned. The magnet was arranged to draw the molecular stream so as to beat against the upper vanes, and the wheel revolved rapidly as if it were an overshot waterwheel. On turning the magnet so as to drive the radiant matter underneath, the wheel slackened speed, stopped, and then began to rotate the other way, like an undershot water wheel. This reversal can be repeated as often as the position of the magnet is reversed.

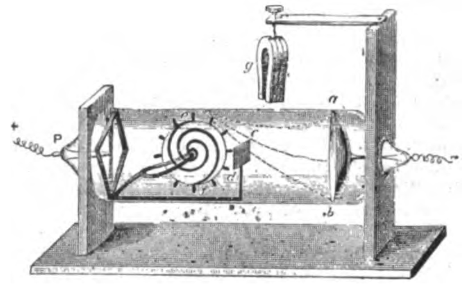


FIG. 17.

We have mentioned that the molecules of the radiant matter discharged from the negative pole are negatively electrified. It is probable that their velocity is owing to the mutual repulsion between the similarly electrified pole and the molecules. In less high vacua, such as that shown in Fig. 16, the discharge passes from one pole to another, carrying an electric current as if it were a flexible wire. Now it is of great interest to ascertain if the stream of radiant matter from the negative pole also carries a current. Fig. 18 is an apparatus which decides the question at once. The tube contains two negative terminals (a, b) close together at one end, and one positive terminal (c) at the other. This enables two streams of radiant matter to be sent side by side along the phosphorescent screen, or by disconnecting one negative pole, only one stream.

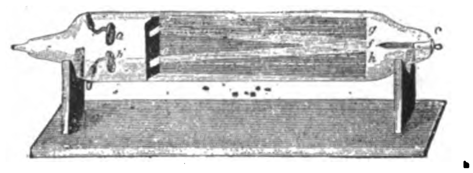
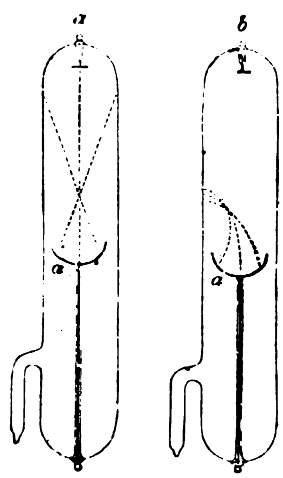


FIG. 18.



FIGS. 19 AND 20.

If the streams of radiant matter carry an electric current, they will act like two parallel conducting wires and attract one another; but if they are simply built up of negatively electrified molecules, they will repel each other.

The upper negative pole (a) was first connected with the coil, and the ray was seen shooting along the line d, f. The

lower negative pole (b) was then brought into play, and another line (e h) darted along the screen. Instantly the first line sprung up from its first position, d f, to d g,, showing that it was repelled, and the lower ray was also deflected downwards; therefore the two parallel streams of radiant matter exerted mutual repulsion, acting not like current carriers, but merely as similarly electrified bodies.

Another property of radiant matter is that the glass gets very warm where the green phosphorescence is strongest. The molecular focus on the tube (Fig. 8) is intensely hot.

An apparatus was exhibited by which this heat at the focus was made visible to the audience.

A small tube (Fig. 19) was prepareu with a cup-shaped negative pole. This cup projects the rays to a focus in the middle of the tube. At the side of the tube is a small electromagnet, which can be set in action by touching a key, and the focus is then drawn to the side of the glass tube (Fig. 20). To show the first action of the heat, the tube was coated with wax. The apparatus was put in front of the electric lantern, and a magnified image of the tube was thrown on the screen (Fig. 21). The coil was set to work, and the focus of molecular rays was projected along the tube. The magnetism was turned on, and the focus drawn to the side of the glass. The first thing seen was a small circular patch melted in the coating of wax. The glass soon began to disintegrate, cracks shooting starwise from the center of heat. The glass softened, next the atmospheric pressure forced it in, and then it melted. A hole (e) was perforated in the middle, the air rushed in, and the experiment was at an end.

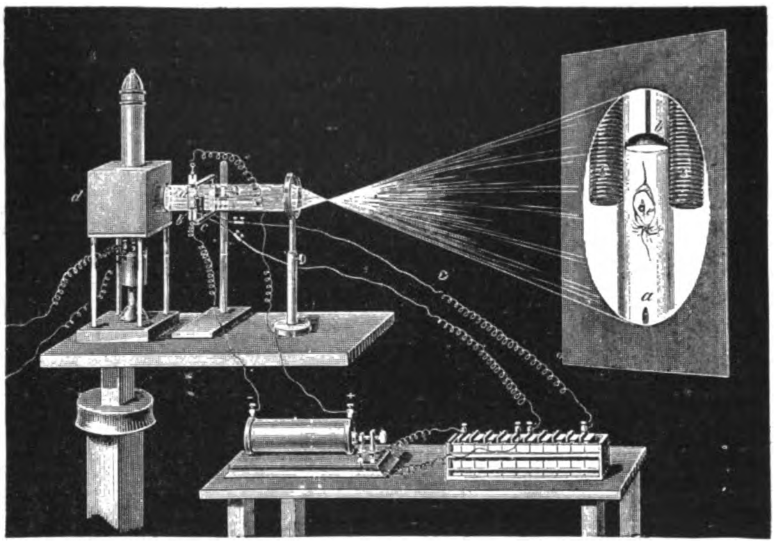


FIG. 21.

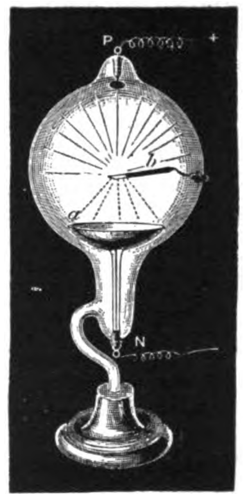


FIG. 22.

We can render this focal heat more evident if we allow it to play on a piece of metal. The bulb (Fig. 22) is furnished with a legative pole in the form of a cup. The focus of heat was deflected just as was the luminous focus in platinum (b) supported in the center of the bulb.

The induction-coil was first slightly turned on so as not to bring out its full power. The focus played on the metal, raising it to a white heat. By bringing a small magnet near, the focus of heat was deflected just as was the luminous focus in the other tube. By shifting the magnet the focus can be driven up and down, or drawn completely away from the metal, so as to leave it non-luminous. On withdrawing the magnet so as to let the molecules have full play again, the metal became white-hot. On increasing the intensity of the spark, the iridio-platinum glowed with almost insupportable brilliancy, and at last melted.

RED GLASS.—Photometrists and others interested in optical research will be glad to know that the firm of Putzler Bros., of Penzig, in Germany, have succeeded in making red pot glass, which is very clear and bright, but is opaque to the whole of the blue side of the spectrum, down to the line of the wave length 628. There has hitherto often been trouble in obtaining good samples of red glass for optical testing work and for obtaining non-actinic illumination.

STUDIES IN HYDRO-CARBON FLAMES—III.

BY DR. W. H. BIRCHMORE.

IT seems quite probable that the extra academic discussion of the nature and action of chemical rays which has begun since the announcement of the experiments of Professor Röntgen will bring about the diffusion of knowledge as to the actinic character of the Bunsen flame, but it has already shown a tendency to limit the field of inquiry.

The Bunsen flame is known of all men; it is a hydro-carbon-gas flame maintained at the most intense possible heat, which heat is limited only by the conditions of supply. This Bunsen flame is usually spoken of as being "faintly luminous," it is commonly called blue, but the color is well known to vary with the pressure and the amount of gas admitted to the burner. Any number of explanations of this "blue color" have been offered, some of them rather far-fetched, but few, if any, discussions of this flame have mentioned that the "blue flame" is not so hot by much as the "lavender" one. This lavender flame is a strictly neutral one, the spectrum is not continuous, but the gas and air must be so nicely balanced that the least possible derangement of the relation between them will precipitate the carbon and produce a continuous spectrum.[1]

THE SPECTRUM OF THE BUNSEN FLAME.—The spectrum of the Bunsen flame varies with every change in the composition of the hydro-carbon burned; not that there are any characteristic spectra in the sense that such belong to nickel, iron, sodium and copper, but the Bunsen flame from a lamp burning alcohol has not the same spectrum as that burning common illuminating gas, but has one which differs from the other in many suggestive ways.

The spectra seem to be a combination of the spectra of carbon at different temperatures, absorption spectra of various sorts, and the spectra of hydro-carbon and air gases, such as are produced under diminished pressure by electrical stress.

Notwithstanding the immense number of individual spectra, there are but three type forms, and these may be parted each from the other, not easily, but by reasonable effort, and these type form differ much in their temperature and actinic efficiency. These spectra may be called: (a) The phosphorescent spectrum, with bright lines. (b) The continuous spectrum, without carbon precipitation. (c) The continuous spectrum, with carbon precipitation.

The first of these is the one usually intended when the Bunsen burner spectrum is spoken of. It is a wide band which may be said to begin at the edge of the green, extend across the blue and enter the violet.[2]

[1]Technically a flame is said to be neutral when it is in just the balanced state described, if the oxygen is in excess it is called an acid flame, if the carbon is in excess it is called a reducing one.

[2]As it is probable that most of the spectroscopes to which my readers have access are those of small dispersion, the description of the spectrum given here is that of the one displayed by a single prism instrument, dispersion 12°, of the Kirchhof and Bunsen pattern, usually called the "large model," made in Geneva and sold by J. W. Queen & Co. The map of the spectrum referred to is the one from Schellen and is to be found in the front of Ganot's "Physics" and many books on chemistry and astronomy.

This band spectrum is not continuous, but has spaces in which the light is wanting, and it is unsteady. While under observation it will be seen to move, now in one direction and now in another. Against this band are projected bright lines.

When oil-enriched water gas is the fuel these lines may be described with sufficient exactness as a green, blue, and a violet line. These lines give a character to the flame and will always arrest the attention of any one examining.

If now the pressure of the gas is increased considerably a

FIG. 1.—PHOTOGRAPH BY BUNSEN BURNER, NON-LUMINOUS FLAME.
(Copyright, 1896, by W. H. Birchmore.)

continuous spectrum makes its appearance. Beginning in the yellow at a mid-distance between D and E, it extends through the entire visible spectrum, and with suitable precaution and apparatus it can be demonstrated far beyond it. The previously mentioned lines are still visible and in addition a line between G and H, which, when present is only less intense than the green line, but this line is unsteady, flashing into intense brilliancy and fading away as suddenly as it appears.

If the gas pressure be increased so that the supply of air aspirated just equals the consumption demand of the gas a new order of phenomena begins.

Up to this point the spectrum has been that of an incandescent gas, under pressure, of course, but now if the gas is in the least excess the spectrum of an incandescent solid is made evident; the bright lines are still there, however, and they are proportionately just as vivid as before. If now the supplies of gas and air are carefully manipulated and the "solid spectrum" be suppressed, and the yellow of the gas spectrum be made equal to the yellow of the same wave length from the sun, a number of differences can be distinguished.

There being no red in the gas spectrum, the solar red as

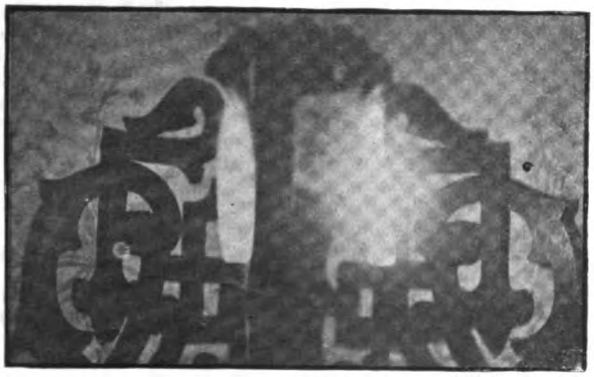


FIG. 2.—PHOTOGRAPH OF BUNSEN BURNERS, ONE LUMINOUS, OTHER NON-LUMINOUS.
(Copyright, 1896, by W. H. Birchmore.)

compared with the red of the gas spectrum is infinite, but when compared by suitable means it is apparent that the violet of the gas spectrum is vastly greater than that of the sun. Using a Bunsen photometer with a suitable screen, and proper precautions, the sun light may be compared directly with that of this gas flame. Under these conditions the sun light shows bright orange, almost red on a violet ground.

ACTINIC EFFECT.—Still more remarkable is the fact that candle-power for candle-power, the Bunsen burner radiation has a much greater photographic efficiency than has the sunlight. The luminous radiation of the particular Bunsen flame with which the photograph, Fig. 1, was taken, was about 0.003 of a candle equivalent, while its actinic effect appears to have been between 112 and 125 candle equivalent. This statement is near enough for my present purpose, and it is accurate within an error of 2 per cent., and may be less. I have

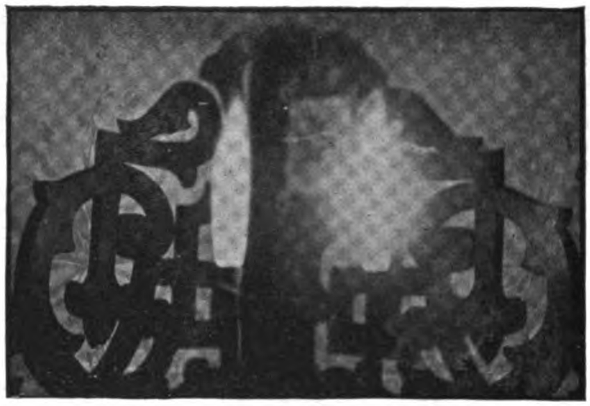


FIG. 3.—PHOTOGRAPH OF BUNSEN BURNERS, ONE LUMINOUS, OTHER NON-LUMINOUS.
(Copyright, 1896, by W. H. Birchmore.)

as yet made no direct efficiency measurements, have only calculated them from other data and it may appear that the actinic efficiency is even greater than this. If the above statement is reduced to a single proportion it makes the actinic efficiency of the Bunsen flame 40,000 times its luminous efficiency at the distance of ten feet.

The essential difference in the photographic action of a Bunsen flame and that of a candle is well shown by the photographs of the two flames side by side in Figs. 2 to 5. These two flames differ in no respect except that one is a Bunsen flame and the other is not. The burner with the wire tied about it is a Bunsen burner, burning with a Bunsen flame. The other is a Bunsen burner identical in every respect, gas supply from the top and all, except that the air is turned off so that it burns with a "candle flame." It has all the characteristics of a candle flame, produces the same electrical phenomena (these will be discussed in another chapter) and it produces a normal radiation.

THE HALO.—Attention is particularly desired for the halo which is seen to surround the central portion of this flame, and which is wanting about the Bunsen.

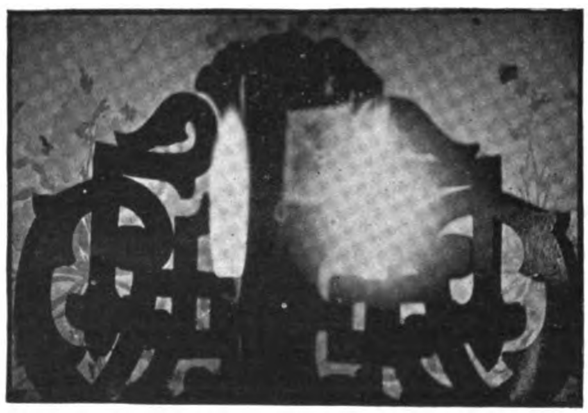


FIG. 4.—PHOTOGRAPH OF BUNSEN BURNERS, ONE LUMINOUS, OTHER NON-LUMINOUS.
(Copyright, 1896, by W. H. Birchmore.)

The halo is shown in Fig. 2 after an exposure of 20 seconds, and in Fig. 5 after an exposure of 120 seconds. I have a variety of plates between these two, but they only serve to emphasize the facts shown in these. The particular points of interest about this halo are: (a) The fact that it exists at all. (b) The fact that the Bunsen flame has none. (c) The fact that it belongs to the area of maximum luminosity. (d) The

fact that it is an invariable accompaniment of the continuous spectrum.

There is one common method of distinguishing between the stars and planets known to every one who interests himself at all in the notions of men uncorrupted by "college" training falsely so called. The cowboy on the plains or the tracker in Canada will alike point out to you the planets by the lack of twinkle. This "sparkle"—twinkle is the same word—of a star is the phenomenon we are studying when we study the halo of this flame. The disappearance of the twinkle and the star's appearance as a point of light, when examined by a telescope, has led to the belief that it was a subjective phenomenon. Lamps are seen to twinkle in a cold, clear night if at a distance from the observer, and when they are examined by a telescope this twinkle disappears. But it must be something real or the camera would not record it. The density and extent are known to bear a definite relation to the time of exposure, and the shape has to do with the flame only.

Examination of Fig. 2 shows that this halo is less dense on the side towards the other flame, and this inequality of density is seen in every one of the pictures which I have taken; the matter forming the cloud, be it what it may, is so acted on by the force set in motion in the other flame focus that it is repelled by it.

The flame of the Bunsen burner burning non-luminous never has this halo. But let the flame become luminous for never

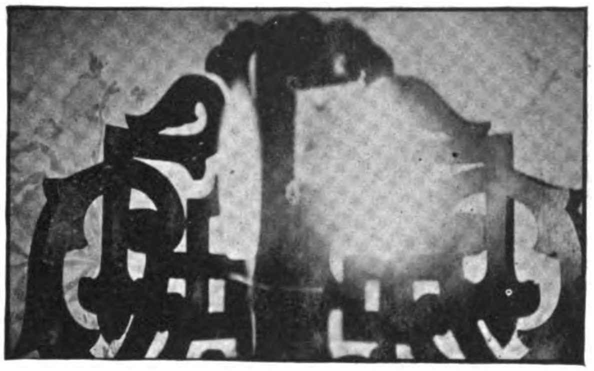


FIG. 5.—PHOTOGRAPH OF BUNSEN BURNERS, ONE LUMINOUS, OTHER NON-LUMINOUS.

(*Copyright, 1896, by W. H. Birchmore.*)

so short a time, let the spectroscope show even for a second the continuous spectrum of a solid, just so sure the camera will show the halo. I have made a large number of pictures of the Bunsen flames under various spectral conditions, and I have never found that the halo appears about a flame which has not shown a continuous spectrum at some time in its life, and I have never found it wanting about a flame which has shown such spectrum. This total absence of the halo around the Bunsen flame, its invariable presence about the luminous one, its greater density on the side away from the fellow burner, are phenomena invariably present under the given conditions. It is still further peculiar that the basis of the two flames are both incandescent gas, the spectra are both discontinuous, as if the gas was heating to precipitate its carbon atoms which, leaving the hydrogen, were either to fall into the grasp of oxygen atoms and burn to gases of combustion, or to grasp each other and go whirling off into space in rings of six atoms. In other words, around each luminous flame a little nebula of carbon exists. Is the combustion center of each flame surrounded by unburnt and unburning molecules of carbon, held near the flame by currents of air yet able to fly away from the center? It seems hardly likely that the radiant energy of the flame can account for all of this disturbance, and yet it must be one of the active factors.

The confined area considered in relation to the length of the flame is peculiar. The resolute refusal to show the center of radiation photographically and the influence of the time of exposure are also suggestive. If the halo were a continuous and persistent radiation then the strength would depend on the life of the flame and it would grow larger and larger, and if two exposures of the same duration are made one at three minutes after the flame begins, and the other at thirty minutes, it is plain that the flame with thirty minutes' life should have ten times as dense a halo as the one from that with a life of three minutes, if the action on the plate were due to the size of the halo. On the other hand, if the halo is of equal and very slight density throughout the flame life, or of increasing density, but of more feeble action from center to edge, the size and relations will depend on the time of exposure.

As was noted, the plane of the halo-equator coincides with the plane at right angles to the axis of the flame. Were this true of the zodiacal light it would present a startling analogy, and one cannot but wonder if the theory that this cosmic halo is produced by the sun as it shines on cosmic dust is true, and that this halo is caused by light shining on the dust in the room. But if it were chemical, actinic light should produce it, and this should come from the Bunsen, and as the disturbance in air dust by the Bunsen is greater, as well as its actinic action, it follows that the pictures of the halo should be larger and more dense.

I think, therefore, that the proposition that it is caused by the precipitated carbon has locus standi, and I invite the attention of students to it as an interesting problem. I think this is still further proved by the continuous spectrum association previously mentioned.

Some time ago I drew attention to the number of classes of rays of the same wave length given off by heated carbon, and stated that, as evidenced by carbon heated by the current, there were at last two kinds making themselves evident by photographs which had no direct action on the eye in producing color sensations or even light sensations. Somewhat similar action appears in reference to these flames. The actinic rays given off by the luminous and non-luminous flames produce substantially the same results, differing only in degree, when reflected from the surrounding objects, but when photographed directly, many divergent phenomena are seen. There is a notable difference, however, when the rays of a luminous flame separated by prismatic action are thrown on a phosphorescent screen. These influences of heated carbon, be they what they may, cease the instant a discontinuous spectrum appears. From these photographs it seems evident that the reverse is true, and that the instant hot carbon is precipitated from a gas a series of waves of some sort are started which it is not possible to produce by the action of heated gases at all.

ARE ROENTGEN RAYS LONGITUDINAL VIBRATIONS?

Professor J. J. Thomson has investigated the question of longitudinal vibrations in connection with the recent discoveries. In a paper read before the Cambridge Philosophical Society he discussed the theory of longitudinal waves from the the point of view of the electro-magnetic theory of light, and showed that on that theory longitudinal waves can exist (1) in a medium containing moving charged ions; (2) in any medium, provided the wave-length is so small as to be compared with molecular dimensions, and the ether in the medium is in motion. It was shown that it follows from the equations of the electro-magnetic field that the ether is set in motion in a varying electric field. These short waves would not be refracted, but in this respect they do not differ from transverse waves which on the electro-magnetic theory would not be refracted if the wave-length were comparable with molecular distances. The properties of the longitudinal waves were developed in the paper. Professor Thompson exhibited a number of photographs which had been taken at the Cavendish Laboratory by Professor Röntgen's method, and experiments made on the Röntgen rays were described. In one of these experiments the photographic plate was placed inside the vacuum tube so as to intercept the rays between the cathode and the walls of the tube; in this case the plate was not affected, showing that the fluorescence of the glass is necessary for the production of these rays. Other experiments were made to see if they could be excited by fluorescence without a cathode; the ring discharge was produced in bulbs, and caused a vivid phosphorescence; a plate protected by cardboard when exposed to the bulb for an hour was not affected, nor was any greater effect produced when the bulb was filled with a gas such as oxygen, which phosphoresces under the discharge. It thus appears that both a cathode and a phosphorescent substance are required for the production of these rays, and that one without the other is inoperative. A series of experiments were made by taking photographs through tourmaline plates, (1) with their axes parallel, (2) with their axes crossed; it was hoped by this method to get some evidence as to whether the rays were longitudinal or transverse. A considerable number of photographs were taken in this way, but no difference could be detected in the obstruction offered to the rays by the tourmaline plates in the two cases. Another method of investigating the same question was described, based on Elster and Geitel's discovery of the influence of the plane of polarization of light on its power to discharge electricity from a metallic surface. The experiments, which were not concluded until the day after the meeting of the society, show that these rays exert the most

powerful effect in discharging electricity whether positive or negative, from an insulated electrified metal plate exposed to their influence. A bulb separated from the charged plate by a board three-quarters of an inch thick covered with several layers of tinfoil exerted a most powerful effect, and it was not until the thickness of the metal between the bulb and the electrified plate was nearly a quarter of an inch that the effect ceased to be perceptible. The electrified plate is a much more delicate detector of these rays than the photographic one, and is more suitable when measurements are required. These results, though by no means conclusive, are in favor of the vibrations being longitudinal.

THE DE LAVAL TURBINE AND DESROZIERS DYNAMO IN THE EDISON STATIONS, NEW YORK.

IN the article describing the stations and work of the Edison Electric Illuminating Company, of New York, in "The Electrical Engineer" of Jan. 8, we noted the contemplated installation in the 12th street station of that company of a 300-horse-power DeLaval steam turbine, coupled direct to a Desroziers dynamo, both machines being manufactured by the Maison Breguet, of Paris.

The DeLaval turbine has been described in "The Electrical Engineer," but in view of this first instance of its application to electric central station work in this couuntry, it may be well to recall the salient features of that extremely interesting engine. The combination of turbine in dynamo is shown in perspective on this page, while Figs. 2, 3 and 4 show details which will explain its operation.

The principle of the DeLaval turbine is exactly similar to that of the Euler water turbine. It is so arranged that the steam only attains momentum when it reaches the turbine wheel. The expansion of steam takes place in diverging conical nozzles, shown in detail in Fig. 2. The smallest sectional area determines the quantity of steam which passes through a nozzle, and the proportion between the areas at each end of the nozzle determines the velocity of steam. If the end of the nozzle is too small, the steam is not quite discharged, and if it is too large the speed is too small. As the steam has lost its pressure when it gets into the buckets of the turbine wheel, this wheel does not require to be tight near the point of arrival of the steam and this is one of the great advantages of the DeLaval steam turbine.

As in the case of water turbines, to obtain the greatest efficiency the disc must run at a speed about half that of the steam. There were many difficulties to overcome to reach such speeds. However carefully the turbine may be manufactured it is impossible, on account of non-homogeneity of materials, to get the center of gravity exactly on the geometrical axis of revolution. Dr. DeLaval finally conceived the bold idea of providing the turbine with a flexible shaft. This flexible shaft allows the turbine to adjust itself and revolve around its true center of gravity while the shaft describes a surface of revolution. At one end the shaft is povided with a ball bearing, G, Fig. 4, to allow it to adust itself. On the shaft of the disc is a pinion, T, Fig. 3, engaging in one or two gear wheels, E, of ten times their diameter, to reduce the speed.

The governor is a centrifugal one, the rings being movable on knife edges with the least possible friction. When the speed becomes too high the weights diverge, their inner parts push a pin, which pin causes the cut-off of steam by the valve S.

The practical advantages which characterize the steam turbine are simplicity of fitting, small frictional resistance, small weight and absolute regularity of speed. The consumption of steam in these turbines is nearly the same as those of condensing compound engines. Numerous tests made in London, France and Belgium have shown that a 75-horse-power turbine requires 20.2 lbs. of steam per horse-power hour, with a boiler pressure of 140 lbs. A 100-horse-power turbine requires 19.1 lbs. of steam per horse-power hour, with 113 lbs. boiler pressure. A 200-horse-power running half load with 70 lbs. boiler pressure required 19.5 lbs. of steam per horse-power hour. A 300-horse-power with -±1 lbs. at the boiler requires only 16.5 lbs. of steam per horse-power hour.

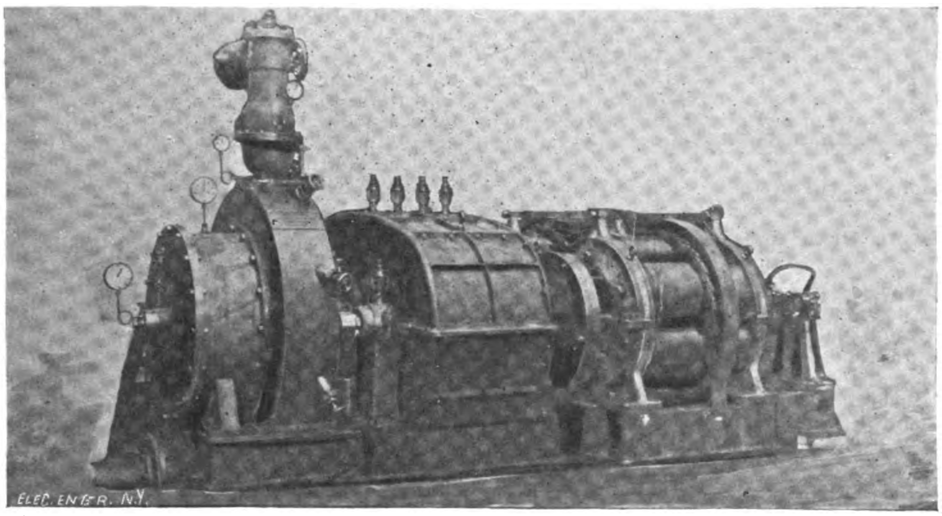


FIG. 1.—DE LAVAL STEAM TURBINE AND DESROZIERS DYNAMO, IN EDISON STATIONS, NEW YORK.

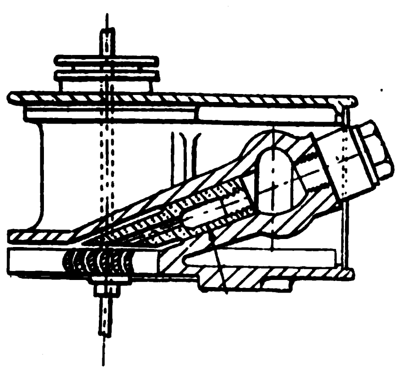


FIG. 2.—DETAIL OF NOZZLE AND DISC.

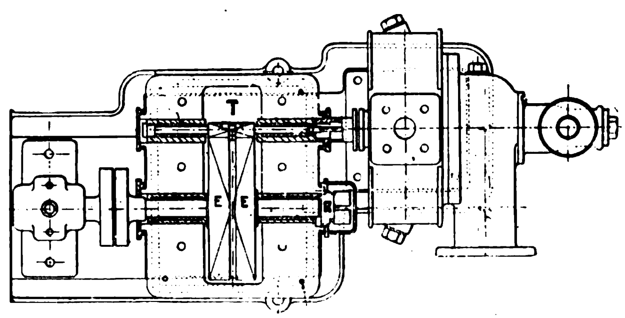


FIG. 3.—DE LAVAL STEAM TURBINE.—PLAN.

The Desroziers dynamo, to which the DeLaval turbine is coupled, is now so well known that no extended description is necessary. A full account of the construction of this machine

will be found in "The Electrical Engineer" of Sept. 20, 1893. We may recall to our readers, however, that the Desroziers dynamo is a multipolar disc machine, the armature conductors being wound on bare cardboard discs. Owing to the absence of iron in the construction, Foucault currents are entirely eliminated, and thus the main cause of heating in the armature is removed. Added to this is the weak reaction on the field, which gives a smooth characteristic curve and a constant efficiency, exceeding in the 100-horse-power machines, 93 per cent. Owing to the absence of iron in the armature, also, the weight of the machine is greatly reduced. Thus, at normal speeds the machines weigh only from 55 to 65 pounds per horse-power of output, and one pound of copper produces 160 watts.

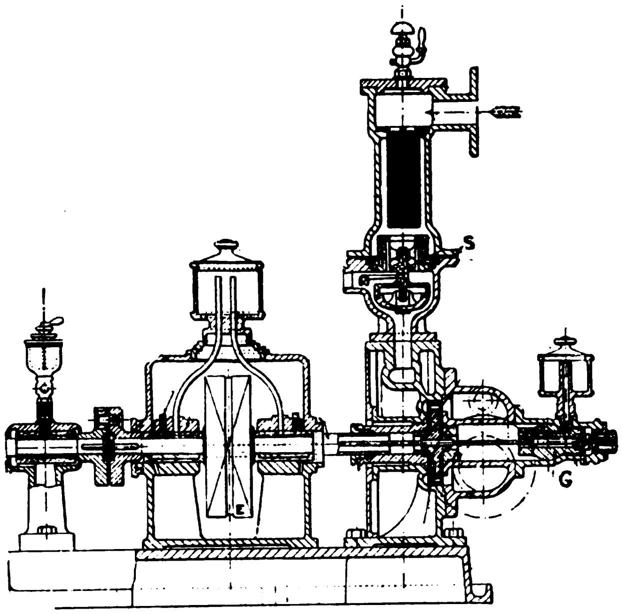


Fig. 4.—De Laval Steam Turbine.—Section.

Two of these steam turbine combinations are now in shape for steam connection, one in the 12th street station and the other in the 39th street station of the Edison Company.

THE SOUTH NORWALK (CONN.) MUNICIPAL LIGHTING PLANT.

BY A. E. WINCHESTER, E. E.

This plant[1] was started Oct. 13, 1892, and has been in continuous successful operation ever since, as will be seen by the following comparison of yearly reports from which it will be seen that each successive year shows a marked improvement over the previous one:

Price paid to the original company for 81 lamps previous to Oct. 13, 1892, when the municipal plant was started, was per 800 c. p. lamp per night on moon schedule, dusk to 1 A. M., about .... 22c.

Cost per lamp averaging 1,400 c. p. per night for year ending Oct. 12, 1893, supplied from city plant, 90 lamps in use, 311 nights per year lighted; no lights on bright moonlight nights. Lighting time from dusk to 1:30 A. M., later when necessary, on special occasions all night; interest on bonds $22,500, at 4 per cent., and depreciation of apparatus at 2½ per cent. on $15,000, value included .... 20¾c.

Cost per lamp averaging 1,400 c. p. per night for year ending Oct. 12, 1894, supplied from city plant, 98 lamps in use, 309 nights per year lighted, no lights on bright moonlight nights; lighting time from dusk to 1:30 A. M., later when necessary, on special occasions all night; interest on bonds, $22,500, at 4 per cent. and depreciation of apparatus at 5 per cent. on $15,000, value included .... 19 2-10c.

Cost per lamp averaging 1,400 c. p. per night for year ending Oct. 12, 1895, supplied from city plant, 98 lamps in use, 317 nights per year; no lights on bright moonlight nights; lighting time from dusk to 1:30 A. M., later when necessary, on special occasions all night; interest on bonds, $22,500, at 4 per cent. and depreciation of apparatus at 5 per cent. on $15,633, value included .... 19c.

The Electric Light Commissioners are continually receiving requests from municipal governments from all parts of the United States and Canada for reports and information regarding the South Norwalk Electric Works, which, though a very small plant, has become widely known as an example of an unusually successful municipal electric light plant, so much so, that many experts, some of them skeptical, have visited it for the purpose of personal investigation as the station register, a book in which all guests are requested to place their names and addresses will show; but without exception all have expressed themselves as convinced of the plant's practical success, and have congratulated the city on its valuable possession, the economy of which they have attributed not only to high efficiency of apparatus, but to careful business management. The distribution of light is said to be unsurpassed by any of the larger cities of this country, it being possible to tell the time from a watch without difficulty at the darkest spot between any two lamps.

Some time ago the city voted to establish a commercial plant in connection with the present street lighting system, the revenue from which it is believed would in a large measure, if not entirely, defray the expenses of the entire plant, and make it self-sustaining, thus reducing the tax assessment to a considerable degree. An appointed committee, including the Board of Electric Light Commissioners, is now carefully investigating the subject, and will soon report to a city meeting the result of their efforts, which will include a plan embodying the latest ideas and improvements in the method of electric lighting. The concentration of the lighting district is such that the low tension direct current is deemed most suitable for all purposes and a storage battery outfit will be considered to take care of the day load, and the maximum night load, so that the generating plant will only operate during the evening, when it will work under full load throughout the run.

The intention is to make the plant a model of practicability and economy in every way, from which all electric light, heat and power required by the inhabitants of the city can be supplied at a reasonable rate, which will return a self-sustaining revenue, as does the present water works.

The very efficient operating force of the plant is composed of three men—Superintendent W. L. Bonnel, Engineer Wm. H. Mosher, Jr., and Lineman Edward Laidlaw—all experts of long experience, as is evidenced by the extremely low rate of running expenses, the neatness of the plant, and the careful and systematic manner in which it is operated.

The plant is in charge of three commissioners, who serve without salary.

[1]For a detailed description of this plant see "The Electrical Engineer," Jan. 30, 1895.

A LIGHTING PLANT WASHED OUT.

The recent storm in Manchester, N. H., and vicinity caused much damage. The most serious blow was at Kelley's Falls, where a part of the dam went out and the ice in the basin behind the dam broke up and went over. The Kelley's Falls Electric Light Works were almost wiped out of existence. Seven men, including Superintendent Whitney and Machine Expert W. R. Smith had close calls for their lives. The crash came unexpectedly. Smith was standing on the canal flume, which was swept into the stream. He floated down the river for a mile, being buffeted by cakes of ice, and reached the shore more dead than alive. The others were caught in the torrent and narrowly escaped with their lives.

The damage to the Kelley's Falls electric light plant is estimated at $50,000. Much of the machinery is in the river.

VIBRATION AND CONDUCTIVITY.

Signor Murani, in "L'Elettricita," describes experiments on the influences of vibration on the resistance of wires. To avoid the heating due to friction, the vibrations in a series of metallic wires were induced by an electromagnetic tuning-fork, wires of hardened iron, platinum, hard steel, hard copper, German silver, and manganin being tested, and in no case was any variation in the electric resistance detected by the most delicate methods. It is consequently concluded that the resistance of metallic wires is not altered by vibrations, all results to the contrary obtained by other observers notwithstanding.

THE CAMPBELL & ZELL COMPANY, through their agent, Mr. A. W. Weller, have sold to the New London (Conn.) Street Railway Company 500 horse-power of Zell water tube safety boilers.

ELECTRIC TRANSPORTATION.

CAN ELECTRICITY SUPPLANT THE STEAM LOCOMOTIVE ON TRUNK RAILWAYS?—IV

BY

Wm Baxter Jr

THE data presented in the foregoing sustain the claim that the substitution of electricity for steam would effect a saving of 55 per cent. of the coal bill, and this would be 5.5 per cent. of the total operating expenses, the coal bill being 10 per cent. of the whole. A saving of 5½ per cent. of the total expenses is not a small matter by any means and a road would be justified in going to considerable expense to effect it.

This, however, is not all that can be saved of the 10 per cent. now required to cover cost of fuel. The saving so far shown only represents that due to difference in amount of coal consumed per unit of energy expended on the track. As will be shown later on, there are sources of loss in the operation of a road by steam that would not exist if electricity were the motive power, and the elimination of these losses would raise the saving in coal consumption considerably above 55 per cent.

The saving in coal alone, however, is not the all-important factor upon which hangs the future destiny of electricity in the steam railway field. There are other directions in which fully as great, if not a greater, saving can be made. This, however, is not all; electricity's claim for a hearing is not based wholly on the question of economy. The comfort and safety of the traveling public, as well as more rapid interurban transit, are paramount factors which must be considered in deciding upon the merits of a system, and in these respects it can be easily demonstrated that electricity is far ahead of steam.

Before going into a consideration of the questions of comfort, safety and greater speed, it will be well to point out briefly the various ways in which electricity can reduce the operating expenses other than the one already given.

In the first place, we have the very important fact that the electric motor does not depend upon the skill of the man who handles it for its efficiency, while the locomotive does. No matter what the intelligence of the motorman may be, the energy absorbed in doing a given amount of work with the same motor will always be the same. This is by no means the case with a locomotive. There are two ways by which the speed of a locomotive can be regulated, one by the movement of the link motion lever, and the other by opening and closing the throttle. If the link motion lever is used, the steam will be expanded in the cylinders and the highest efficiency obtained. By using the link motion the throw of the valve is shortened, in precisely the same way as it is in the various types of high-speed engines that have a single valve, the motion of which is regulated by the governor. Under these conditions the locomotive becomes a variable cut-off engine, and works at a high rate of efficiency. But when the throttle is used to regulate the speed, it becomes simply a slide valve engine, and uses a much greater amount of steam to do the same work. Therefore, the amount of coal consumed to do the work will depend upon the way in which the speed is regulated.

The amount of coal used to generate steam will further depend upon the skill and care of the fireman. It may not be supposed that the difference in coal consumption, due to the way in which the locomotive is handled, amounts to very much, but actual records show that it is as much as ten to fifteen pounds per train mile. This is one point in which steam is at a decided disadvantage when compared with electricity. It may be said that what is true of the locomotive is true of the engine in the power station of an electric system, but such is not the case. The engines regulate themselves by the action of the governor, and so far as the efficient use of steam is concerned, are no more dependent on the skill of the engineer than the motor is. As to the wastefulness of the fireman, it is not at all likely to be as great in the station as on the locomotive.

Another direction in which electricity has an advantage over steam is in the weight of locomotives required to haul a given load. A locomotive weighing, say, 60 tons, will have about 45 tons on the drivers, possibly 50 tons. The tender will weigh about 30 tons, and coal and water about 10 tons more. Therefore, out of 100 tons of engine, tender, coal, and water, from 45 to 50 tons only rests on the drivers. At slow speeds, the capacity of a locomotive depends, not on the amount of work the steam in the cylinders can do, but on the adhesion of the wheels to the track, or, in other words, on the weight on the drivers. As only half the weight rests on the drivers, the other half is useless, and is just so much dead weight that has to be hauled over the road to supply the motive power.

An electric locomotive of half the weight will do just as much work, at low speeds, because all the weight would be on the drivers. A locomotive not only has to exert enough energy to draw the train of cars behind it, but must also draw its own weight. It follows, therefore, that the lighter the locomotive the less power that will be required to draw the train. In high-speed passenger service, the weight of locomotive and tender is a very large portion of the entire weight of train. The Empire State Express train on the New York Central Railroad weighs on an average 340,000 pounds, while the engine, including tender, weighs 200,000 pounds, which is about 37 per cent. of the entire weight. This, it must be admitted, is an exceptional case, but in all high-speed work, the ratio of engine to train weight will not fall very far below this figure.

With local passenger trains this percentage will drop considerably, and will be still lower in freight trains, but, whatever it may be in any given case, it is evident that it would be lower with electric locomotives, from the fact that all the weight would be on the drivers. Any reduction that may be made in the total weight of train, by a reduction in the weight of motive power portion will represent just so much gain in favor of the electric system.

There is another direction in which a considerable saving in coal can be made, and that is in the operation of switching engines. This point has not heretofore received much attention in discussions on this subject. It no doubt has been considered of not enough importance to be considered as a factor in the general operating expenses of a road; but such is not the case. A few figures taken from the reports of a large number of roads will show its bearing on the subject.

Take, for example, the total of all the roads in the State of Ohio, Illinois, and New York. According to the reports the train mileage is as given in the following table:

Table 9.

Total Mileage in Ohio—Eighty-Seven Roads Reporting.

Total mileage of passenger trains	24,182,674
Total mileage of freight trains	32,901,611
Total mileage of mixed trains	912,925
Total	58,004,210
Total mileage of switching engines	14,935,541
Total mileage of construction engines	1,339,635
Total of switching and construction	16,275,176
Grand total	74,279,386

Percentage of switching and construction mileage of passenger, freight, and mixed equals 28 per cent. approximately.

Total Mileage in State of New York—One Hundred Roads Reporting.

Total passenger mileage	65,922,703
Total freight mileage	95,914,305
Total	161,837,008
Total all other mileage	42,809,169

Percentage of switching, etc., of passenger and freight equals 26 per cent. approximately.

Total Mileage in State of Illinois.

Total passenger mileage	29,235,262
Total freight mileage	37,801,675
Total	67,036,937
Total switching mileage	17,496,226
Total construction mileage	1,017,412
Total	18,513,638

Percentage of switching, etc., of passenger and freight mileage equals 27 per cent approximately.

If these figures, which are taken from the official reports, are correct, then the mileage of switching engines amounts on an average to about 27 per cent. of the revenue earning mileage. It is but fair to say, however, that a close inspection of the reports leads one to believe that the mileage of switching engines, as estimated, is possibly based upon the time the engines are in service, it being assumed that a unit of time represents a certain number of miles run. This conclusion is strengthened by the fact that the miles run per year by switching engines is in some cases greater than that of freight locomotives. Inasmuch as switching engines are most of the time standing on the track waiting for trains to be made up, and, when in motion, only go a short distance at a time, it is quite evident that the total distance covered in a year must be far below the average of engines in regular service.

A more accurate estimate of the relation between work done by switching and revenue-earning locomotives can be made by comparing the coal consumption in both cases, and also the number of engines used in each class of service. According to the Illinois State report, the total amount of coal consumed by all the locomotives in the State engaged in passenger and freight service for the year 1894 was 3,076,978 tons. The consumption by switching and construction engines was 596,-927 tons, of which 30,228 tons, or a trifle more than 5 per cent., is allotted to construction work. These figures show that the coal consumed by switching engines amounts to about 19 per cent. of that used by freight and passenger locomotives combined.

Taking the relation between the number of locomotives in service, we find that in the State of Ohio there are 1,252 passenger, 2,953 freight, and 899 switching engines. In Illinois there are 2,083 passenger, 4,797 freight, and 1,455 switching engines. Taking the sum of these two States we find that the number of locomotives in the passenger and freight service is 11,085, while those used for switching purposes amount to 2,354, or something over 17 per cent. of the entire equipment.

When we consider the character of work performed by switching engines it at once becomes evident that this is a field in which the saving that can be effected by electricity will be relatively very great. A little reflection will show that the coal consumption per horse-power in this class of work must be very high, because the engines are in motion only a small portion of the time, and then, in most cases, only run short distances. Sometimes an engine may be engaged for hours, hauling a few cars at a time, first in one direction and then in the other, in the process of making up trains. The actual work done in this kind of service is very small, and if reduced to an average for the entire time over which it is spread, would perhaps not amount to more than 25 or 30 horse-power continuous output. But, although the engine is only required to do work for a few minutes at a time with intervening periods of rest of more or less duration, the fire has to be kept bright and a full head of steam on so as to be ready to move at a moment's notice. It is plain to be seen that under such conditions more coal is consumed keeping the locomotive in readiness than that required to do the actual work.

Electric motors would do this kind of work at a very much higher efficiency than locomotives, for the very simple reason that no energy would be drawn from the power station except when the motors were in motion.

ELECTRIC TRACTION BY POLYPHASE CURRENTS.

What we believe to be the first application of polyphase currents directly to electric traction, says the London "Electrician," is now being made by Messrs. Brown, Boveri & Co., at Lugano, in Switzerland. At this place an electric railway is being equipped with polyphase plant, and will, it is hoped, shortly be ready to start work. Preliminary trials have already been made with successful results.

The power for this railway is derived from a waterfall, where a power house has been installed with a 300-horse-power turbine, driving two 150-horse-power three-phase alternators. The power is generated at 5,000 volts, and a portion of it is used by a chocolate factory near the power house. The three-phase generators are of a special type in which the only moving parts are the iron star-shaped pole cores. Both the field coils and the armatures are stationary.

Three-phase current for the railway is conveyed at 5,000 volts, overhead, over a distance of 12 kilometers (7½ miles) to Lugano, where it is transformed down to 400 volts by ordinary transformers. The power is there distributed to the cars by means of two aerial or trolley lines, the third conductor being supplied by the rails. Three-phase motors on the cars receive power through a double trolley-wheel apparatus; and a special form of controller is used when varying the speed or reversing the car. The motors are designed to give a normal speed of 15 kilometers (9⅜ miles) per hour.

The advantages which attend the use of polyphase currents for electric traction are, principally, in enabling power to be derived from a distant source, and in allowing the use of motors which require no commutator, collector, nor bare electrical conductor upon them. On the other hand, a double trolley line and the duplication of the trolley collector wheels are rendered necessary. Of the modifications in the controller which are involved, we cannot now speak particularly; though it seems probable that a more complicated construction than where the current is continuous would be essential, this need not, however, necessitate additional complexity in the manipulation of the controller. The use of two overhead conductors must also present a disadvantage from the increased risk of breakdown due to a telegraph or telephone wire falling across them.

A NEW METHOD OF TESTING RAIL BONDS.

THE beautiful "Gorge Road" at Niagara Falls was equipped with the plastic bond, which was applied when the road was built last August. Although Mr. J. K. Brooks, the superintendent of the road, never had the slightest trouble from a single joint, and although he had once a month removed angle plates and examined the bonds, always finding them in perfect condition, the president determined to have a test made of every bond on the line now operated from the Whirlpool Rapids to Lewiston.

With seven miles of track and rails 30 feet long, it was thought to be a difficult matter to get an accurate reading of the current and drop at each bond. But a novel method suggested by Mr. Harold P. Brown enabled the superintendent to complete the work in two hours. The test was a great triumph for the plastic bonds, since it showed that not a single bond was defective and that the drop on each joint with 100 amperes current was but 0.005 volt, or ⅛ that of a new copper bond 8 inches long and 0.42 of an inch in diameter.

Two large double truck cars were placed 20 feet apart and on their projecting bumpers was laid a strong wooden beam 21 feet long and 6 by 8 inches in section. This was firmly lashed in place with ropes; the drawbars were then joined together and a strain put on their springs with a block and tackle so as to take up any lost motion between the cars and the beam. This arrangement left just 28 feet between the rail contacts of the rear wheels of No. 1 car and the front wheels of No. 2 car.

These trucks were then connected by an insulated wire in which was interposed a very low reading voltmeter. A high reading voltmeter was placed between trolley and rail and an ammeter put in series with the motors. Then the motors of No. 1 car were started and brake set on No. 2 car until 100 amperes were required to run the cars at about 3 miles an hour. It is evident that as the train moved away from the power house, the low reading voltmeter would indicate the drop in pressure due to the resistance of the rails and joints between the cars.

The rail joints are placed in the center of the opposite rail, and therefore during a movement of 2 feet the rear truck of No. 1 car and front truck of No. 2 feet were on the same rail, while there was a joint between them on the other rail.

During the next 13 feet there was a joint in each rail. The consequent variation in the voltmeter's reading represented the increase of drop due to one joint. At its lower point, which would be held for about one-half a second, the reading represented the drop due to 28 feet of unbroken rail, in parallel with a similar length of rail having one joint and a pair of plastic bonds. For the next 3¼ seconds the reading would be higher since there was a joint in each rail. Knowing the drop per foot of rail with a given current, the readings were easily verified by calculating the total drop and comparing it with the indications of the high reading voltmeters on the car at the end of the line and at the power house.

This is believed to be the first time that a test has been made of each bond on an electric railway and the results are certainly remarkable. An interesting feature of the test was the performance of the Westinghouse motors, which pulled the two heavy cars up the hill at the Lewiston end with only 20 amperes.

JERSEY TROLLEY TO CONSOLIDATE.

The combination of all trolley companies of New Jersey, which has been under consideration for over a year, is practically completed, it is stated, and the incorporation may be recorded any day.

The proposition was definitely decided on at a recent meeting of representatives of the interests involved. Among those present at that time were: E. F. C. Young, president of the Consolidated Traction Company; David Young, the general manager, and Joseph Coult, the counsel of the Consolidated Traction; Frank Bergen, representing the Elizabeth lines controlled by John Kean; Gen. Bird W. Spencer, of the lines running through Bergen and Passaic counties; Garret A. Hobart, counsel of the Paterson lines; President Moore and Thomas C. Barr, of the Trenton lines; President Tierney, of the North Bergen Traction Company, of Hoboken; Edward Ambler Armstrong, counsel of the Camden corporations that conduct the street car systems in that city; Elias S. Ward, president of the South Orange line, and one of the promoters of the North Jersey Traction Company, and Andrew Radel, representing the New Brunswick system.

OPERATING EXPENSES OF ENGLISH ELECTRIC ROADS.

The recently published accounts of the Liverpool Overhead Railway and the City and South London Railway Companies, which have been recently noted in these columns, are quite worthy of a more detailed consideration than they usually receive. It is hardly necessary to point out that the only point of semblance between the two lines is the electrical propulsion. True, they have many characteristics in common which appertain to ordinary railway practice, but to illustrate the difference between running trains through underground tunnels, which are unaffected by climatic changes, and propelling trains on an overhead structure, subject to many changeable conditions, it is only necessary to refer to cost of maintenance of way, work, etc. For a train mileage of 321,417 the Liverpool line spent £3,619 in the latter half of 1895, while the City and South London with 227,350 train miles cost £462; it is true that the South London line is just about half the length of the Liverpool Overhead; but that would not account for the difference of eight times the cost. As a matter of fact, very considerable sums are spent by the Liverpool Company in operating swing bridges across the docks; the repairs of structure and opening bridges alone absorbing £1,240. Before proceeding further it would be as well to give a table setting forth the cost per train mile on the two lines for corresponding periods.

Cost Per Train Mile.

	City and South London Ry. 1894.	1895.	Lvpl O'head Railway. 1894.	1895.
Maintenance of way, works, etc..	.54	.48	1.99	2.68
Locomotive and generating power	6.02	6.0	3.23	3.64
Traffic expenses	5.95	5.85	5.07	4.94
General charges	1.73	1.71	1.52	1.53
	14.62	14.51	11.98	12.92

It will be seen that the cost of loco and generating power is very much less on the overhead than on the underground line. The sum spent in this department by the Liverpool line stands at £4,921, against £5,707 on the South London system. The lower cost per train mile is, of course, partly accounted for by the heavier train mileage on the overhead line, for certain charges under this heading would not be increased on the South London line if more trains were run. The principal sum is in connection with wages for working generating engines and motors, the difference between the two systems being only about £13. We may always expect coal to figure somewhat largely in running expenses of London lines, and it is doubtful whether they will ever be quite as low as at Liverpool, although it may be expected that there would be, occasionally, greater losses of power on an electric railway worked in the open. But all things considered, we may reasonably doubt whether an increased train mileage on the city line would have brought down the cost to anything like the favorable figure obtained at Liverpool. What we have said about the power expenses applies equally to "traffic expenses." This item on both lines is very much the same, and there would be probably a slight reduction in the case of the City Company if more trains were run. In justice to the company, however, it should be mentioned that a considerable amount is included in this item for hydraulic power for lifts.

It is not easy to discover the number of passengers carried per train mile on both lines, but the receipts are a little curious.

	1894.	1895.
Liverpool Overhead	18d.	22d.
City and South London	24d.	25d.

While the city line obtains a considerably higher sum per mile, the increase in receipts per train mile on the Liverpool system are most marked. It would be difficult to understand if the city company's receipts were not higher than those at Liverpool, for a comparison between the two neighborhoods would show that while the Liverpool Company traverse occasionally somewhat thinly populated districts, the South London line passes through densely populated neighborhoods; but, as we have often said before, the city line will not be worked to the best advantage until the line is extended much beyond its present limits.

Notwithstanding the fact that the total expenses of operating the Liverpool overhead line is 12.92d., the economical nature of electric propulsion is placed beyond a doubt. The cost of working the line will compare favorably with the best managed steam locomotive system. It is not easy, of course, to apply the figures to tramway practice, indeed, conditions are so absolutely foreign to what obtains in ordinary streets that it would be useless to make the attempt, but it is not too much to say that the figures relating to cost of generating power would form no bad argument for electric traction on ordinary tram lines.—London "Electrical Review."

THE WINTER'S EXPERIENCE ON THE LENOX AVE. CONDUIT ROAD, NEW YORK.

The underground road which the General Electric Company installed on Lenox avenue, New York, has emerged successfully from the tests to which the recent severe snowstorms have subjected it. During the violent snowstorm of the 11th of March, the operation of the road did not cease for an instant. The snow began to fall about 8 o'clock in the morning and the snow-sweeper was started out over the line, but before it could make the complete trip the sprocket wheels of the broom broke, and it was necessary to push the sweeper back into the barn for repairs. Not until 4 o'clock in the afternoon was it ready to go out on the tracks again. Meanwhile the service of the road was conducted without any stoppage, and the cars ran over the unswept tracks with no greater delay than would be ordinarily caused by considerable slipping of the car wheels on the snow-covered rails; it took about eight or ten minutes longer to make the trip.

At some points on the line the snow was swept by the wind into drifts, making it necessary for the motorman to back his car to get the necessary momentum to push his vehicle through the drifted snow. At 4 o'clock the snow-sweeper cleared the line of the snow and regular schedule time was again resumed.

About 8 o'clock the storm turned to sleet and hail and as it fell covered the rails with ice. Notwithstanding this, the cars ran under their usual headway.

On the Lexington avenue electric conduit road a gang of men swept the tracks and on this line the cars made schedule time while the bad weather prevailed. Throughout the duration of the storm no electrical trouble of any kind was developed either in the conduit or in the cars. The rolling stock of the electric conduit lines of the Metropolitan Traction Company is now undergoing a large increase. Equipment has been started on a number of new cars and they will be put into service as soon as they are ready.

LETTERS TO THE EDITOR.

AN EXPLANATION WANTED.

Kindly ask your readers as to their ideas concerning the following experiment:

If an incandescent lamp of 16 c. p. on a 110-volt circuit is screwed in its socket loosely, so that it does not light, but by gentle tap would light, be struck at the socket suddenly with a piece of wood, a glow of light is seen for about an instant similar to that of a phosphorescent glow? The glow is only visible at the base of the lamp. At one time it was so bright that it was visible in the sunlight. J. M.

New York.

SOCIETY AND CLUB NOTES.

NEW YORK ELECTRICAL SOCIETY.—ROENTGEN RAYS.

A meeting of the society will be held at Columbia College, Madison avenue, and 49th street, on Thursday, the 19th inst., at 8 P. M. Mr. Max Osterberg will lecture on "The Röntgen Ray; a Record of Experiment and Speculation." Mr. Osterberg will review carefully and thoroughly all the developments that have been made up to date in the investigation of the remarkable phenomena to which attention was first drawn by the interesting work of Professor Röntgen. The lecture will be supplemented by a display of apparatus used in photographing through opaque objects, and illustrated by lantern slides, and there will be shown various Crookes tubes, especially designed for this class of work. The meeting promises to be one of the most interesting and important held by the society, and that is saying a good deal.

UNDERWRITERS' RULES CONFERENCE.

As already announced, the conference under the auspices of the National Electric Light Association, of electrical, insurance and allied interests, looking to the adoption and enforcement of a national code of rules for electrical construction and operation, will be held this week, on Wednesday and Thursday, at the headquarters of the American Society of Mechanical Engineers, 12 W. 31st street. Its deliberations will be watched with much interest.

THE

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CONTENTS.

A TIME OF TRUCE.

WE print elsewhere in this issue the official statement of the terms upon which the compact so long and assiduously worked for has at last been arrived at between the General Electric and Westinghouse Companies. The lawyers have had their way for some years past, but just now the bankers are on top, and propose to see that some of the money which has hitherto been spent in litigation shall go in dividends, or at least in supporting the value of the stock by tangible assets and bank reserves. At least, this is the first superficial view of the situation, for it may prove that after all, having agreed to let each other alone, the two great companies may turn their legal artillery on the common outsiders. As things stand, the arrangement ought easily to save the two companies $500,000 a year in legal expenses, all told; and to that extent should be better able to pay dividends; but if the two Catholic powers should now combine to crush out the Protestant schismatics and heretics by a joint war of inquisition and extermination, more money than ever may be needed for belligerent purposes.

Broadly considered, the arrangement is sagacious and worthy of commendation. The electrical industries need peace, if but for a time. The cutting of prices; the uncertain value that has begun to attach to patents, whether sustained or not, and the demoralization of warfare, have brought about a state of things that no one desirous for the solid growth of electric light and power could regard with pleasure, or with anything but feelings of regret and anxiety. We believe both parties to be sincere in their desire for peace, and honest in their determination to maintain it. We would be glad also to know that the principles to which they now give limited application were accepted by them and others as worthy of adoption throughout, so that the revenues squandered in fighting might not only be conserved but increased by judicious agreement upon terms of royalty along many lines. During the great contest over the incandescent lamp, we ventured to urge a policy of conciliation which would have respected patents, protected prices, and brought prosperity. The victory that was won is perhaps the hollowest on record. It cost a magnificent fortune and there is absolutely not a cent to show for it.

Whether the General Electric Company can now rehabilitate itself financially remains to be seen. Its capitalization is enormous, and it owes not far short of 20 per cent. on its preferred stock. The common stock is quoted at prices around 40, but it is doubtful whether it would have any value under any proper plan of reorganization. One of the New York papers in discussing the theory that since the preferred stock sold at 71 and the common around 37, one of the two stocks was not at a normal price, says: "The price of the preferred stock carries cumulative dividends at 7 per cent. for over two years and a half, so that the stock was really selling around 53. Those who worried over the relative prices of the two stocks overlooked the fact that while the preferred stock cannot pay over 7 per cent. dividends, the amount of possible dividends on the common stock is unlimited." The idea of dividends being "unlimited" on General Electric common is nothing short of deliciously comic. The savings on litigation and labor, as well as the gains due to better prices, will have to be abnormally large before the dividends on the common can even be "limited."

As to the feasibility of a control by this new alliance of the vast domain of electric light and power, we have no belief in it whatever. Each attempt in that direction is a more gigantic failure than its predecessor. The fact is, there never was a time of better opportunity for free development in different directions. The very fact that the patents of Mr. Tesla constitute the main basis of the 37½ per cent. of the Westinghouse Company's part in the pool shows how rapidly times change. A few years ago, Mr. Tesla's name was known only to a few, and his work in power transmission is a recent development, the practical part of which all lies in the last three

or four years. If a newcomer can thus revolutionize a field of work so swiftly and so radically, it is in itself an evidence of further and far-reaching changes, perhaps by himself, most assuredly by somebody. The age of great inventions in electricity is not past; it has only just begun, and the whole drift of electrical work to-day is away from monopoly.

INVENTION IN ELECTRICAL DETAILS.

ONE cannot but feel that justice has been done by Judge Coxe in his decision, the text of which is printed in this issue, awarding due credit to Mr. Stieringer for his early work in the invention of the combination fixture and the insulating joint. A previous decision directed against a broader patent had held that the improvements shown would have suggested themselves to any intelligent mechanic; but on the reissue Judge Coxe takes a fitting opportunity to praise work which lies at the bottom of the real success of electric lighting, and which it seems to us differentiates the inventor very distinctly from the mechanic. There are broadly two classes of inventors, one of which grasps the underlying philosophical principles and gives the world a wealth of broad, new ideas. Electricity to-day is suffering from an embarrassment of riches in this respect, having all the ideas it can use for a century to come. The other class of inventors comprises men of a mechanical turn of mind who see how the new ideas can be adapted to old conditions, or can be carried out in novel but operative devices. Occasionally a great inventor comes along who has a place in each group, but as a general thing, the work of the first class depends greatly on the work of the second, and without it would often fail to materialize in public benefits. Mr. Stieringer and other men of insight like him have placed the arts under great obligations by the inventive mechanical faculty of high order brought to bear on the weighty problems of smelting true metal of practicable forms out of the crude ore of fundamental inventive conceptions; and we are only sorry there are not more like him. The electrical business to-day stands sorely in need of men who will improve, perfect, cheapen, and simplify hundreds of its existing devices and invent others without which many of the new arts limp along in immaturity.

THE SOUTH NORWALK MUNICIPAL LIGHTING PLANT.

A LITTLE over a year ago we published a description of the municipal electric lighting plant at South Norwalk, Conn. This plant has been pointed to as a model of its kind, and this year's report, by the commissioners having it in charge, shows a still further reduction, from 19 2-10 to 19 cents per lamp per night. Advocates of municipal plants are so prone to seize upon the figures of plant operating expenses without inquiring into the details by which given results are reached, that it may be well to remark here that the South Norwalk plant is operated on the moonlight schedule, and ran last year 317 nights, shutting down regularly, between 1:30 and 2 A. M. It will be noted, therefore, that the city is not lit all night. In calculating the cost per lamp the report very properly includes the interest on bonds, and all apparatus subject to wear and tear has been charged at 5 per cent. for depreciation. Accepting these figures as they stand they show excellent management, and just what one might expect from a private plant with an owner alive to his own best interests. But the conditions which so nearly approximate private ownership in South Norwalk are just those which cannot be counted on to exist in other cities, as a rule. To begin with, the Electric Light Commissioners at South Norwalk serve without salary, and one of them, an electrical engineer himself, has the plant constantly under his professional eye, and volunteers his professional services free. Adding as small a sum as $1,000 as salary of the Commissioners or for professional services to an outside consulting electrical engineer, would increase the total present yearly operating expenses ($5,902.25) close on to one-sixth, bringing the cost up to 22½ cents per lamp. Taking all the conditions into consideration, therefore, and not even including loss of city revenue from water and real estate tax which a private plant would have to pay, we do not see that the results reached at South Norwalk are remarkable. Indeed, they go to prove what we have all along contended, that the conditions for successful municipal plants are just those which, sad to say, are thus far wanting in American cities. It would, we believe, be a difficult matter to find another such patriotic commission as that having in charge the municipal electrical work at South Norwalk, and we extend to that commission our congratulations on their excellent work. But we would like to utter a friendly note of warning as to the contemplated extension of the city's plant for the purpose of furnishing light to private customers. The revenue obtained from private consumers, it is expected, will eventually pay the expenses of the public lighting, so that the city will be in the lighting business for actual profit. This is in direct opposition to the fundamental principles of the "municipalites," and we think the days of the commission's happiness would soon be over. If we are not greatly mistaken, electric light consumers would "kick" vigorously against being compelled to pay for street lighting which is intended for the benefit of all citizens and to which all should contribute alike. But aside from this consideration, the business of private electric lighting, as a business, is so entirely different from that of public lighting that to make it successful requires a combination of elements which cannot be reasonably hoped for under municipal management. For the sake of the commission's past good record and for their future peace of mind, we would urge them strongly to stick to their present restricted public lighting only.

WHAT WE ARE COMING TO IN TELEGRAPHY.

WITH a view to ascertaining the highest speed at which telegraphic characters can be legibly recorded, Mr. P. B. Delany, in some recent experiments, succeeded in transmitting by his machine system 8,000 words per minute, and obtained a plain reproduction of the signals by electrolysis on the chemically prepared receiving tape. The circuit was an artificial one of 650 ohms, 2.95 microfarads, and the electromotive force was 115 volts. This is about the equivalent of an ordinary telegraph line of 100 miles in length, or, say, New York to Philadelphia. At this speed the perforated tape upon which the messages were composed passed through the transmitting machine at the rate of 27½ feet per second, and the impulses comprising the letters traveled at the rate of 2,500 per second or 133 words, equal to six ordinary telegrams of 22 words each in a single second. At this rate the next few years must bring about great changes in methods of correspondence, and, inevitably, a large portion of the ninety millions now annually expended on wheel transportation of the mails will be diverted to the telegraph. Why not?

CAN THE ARC BE SUPPRESSED?

PROGRESS in the electrical arts has done much to lessen the danger and destructiveness of arcing at switches, but with the constantly increasing potentials employed and the heavy currents now called for in lighting and railway service, the arc still possesses sufficient obnoxious qualities to make its removal well worth study and experiment. Mr. A. J. Wurts, whose classical work in suppressing arcing in lightning arresters is well known to our readers, has recently turned his attention to the arcing at switch contacts and on another page gives the results of his experiments thus far conducted. One cannot read this record without recognizing that, though scarcely begun, Mr. Wurts' work will end in the development of a practical method of arc suppression at all station switches; and that the time is not far distant when that manifestation will be considered a relic of barbarism.

TELEPHONY AND TELEGRAPHY.

CHAROLLOIS MILITARY TELEPHONE SYSTEM WITH SINGLE UNINSULATED WIRE.[1]

AMONGST the resources that modern science places at the disposal of armies in campaign, certainly telegraphy and telephony, notwithstanding their modest position, constitute most important aids to victory in modern warfare. With their aid, commanders of armies can centralize almost instantly all the information required, and thus arrange their forces as advantageously as possible. By their means remarkable precision and rapidity are imparted to military operations. In

FIG. 1.—THE CHAROLLOIS ARMY TELEPHONE SYSTEM.

short, they enable orders to be transmitted in all directions with the precision and promptness of direct commands. It was by endeavoring to impart to the telephone, as used for campaigning, all the practical qualities that it lacked, viz., simplicity, lightness, solidity, facility and rapidity of installation, convenience in communication, and to render the very valuable auxiliary easy of manipulation that Captain Charollois, of the French Army, was at first led to use only a single wire for his telephonic transmissions, using the earth as a return.

This first point is of great importance in itself; but its value is enhanced by the proof of the uselessness of insulation in the wire. In fact, as the result of numerous experiments, Captain Charollois showed that a metallic wire, unwound along the ground, without any precaution as to insulation, had the property of conducting to comparatively great distances—20 kilometers at least—the induced currents circulating between two electric, or even simply magnetic, telephones, placed at the extremities of this single wire, considered as a line, the return being made through the earth. After many experiments and trials, Captain Charollois has been led at last to use a compound wire of pure copper, with a steel core. This wire possesses all the qualities for the purpose, conductivity, solidity, lightness, flexibility; it does not become oxidized, and is inexpensive.

Captain Charollois has also brought out a microphonic transmitter and receiver, so sensitive that conversations can be exchanged in the ordinary voice, at a distance, without having to lean over the apparatus, as we generally have to do with ordinary telephones. To obtain greater precision in communication, and, above all, to render the call bells more distinct, small dry batteries are used, attached to the transmitter, and enclosed with it in a sheet iron case for protection.

The telephonic post thus formed is carried on the back, and communication is obtained by uncoiling the wires by means of a special reel, the return being effected through the earth by the employment of rods, or even bayonets buried in the ground and connected with the post by earth terminals. Fig. 1 shows the soldier provided with an electrical telephonic apparatus fixed on his back by means of straps, like the ordinary knapsacks, and holding in his hand an unwinding spool. The engraving represents the traveling post at work, with the bayonet buried in the earth for the return circuit. Fig. 2 shows the transmitting apparatus.

Organization of the Regimental Telephone Service.—This organization comprises two distinct services: 1. The regimental services, entrusted to the sappers. 2. The company service, entrusted in each company to four soldiers and a corporal appointed by the captain.

The Regimental Service.—The object of the regimental service is to establish telephonic communication between the regiment and the brigade or division, and also for all operations requiring lines of great length. On fields for shooting practice, these movable telephone lines are also used, and they are of the greatest service in artillery practice and regulation shooting. These lines, which consist of wires 6-10 of a millimeter in diameter, may be 20 kilometers in length, and must often remain in position for several days without being taken up. They have, therefore, to be laid with a certain amount of care; the apparatus required is as follows:

Regimental Apparatus.—Six unwinding reels, 6 kilometers of wire; six magnetic telephones, three hooked bamboo rods, four earth terminals, four hooks for suspending the telephone. The weight of the reel, when wound with 1 kilometer of wire, is 3.5 kg.

The Company Service.—The object of this service is to enable the company to establish, under any circumstances of the campaign on the field of operations, one or more telephone lines capable of attaining a total length of 4 kilometers. The principal cases in which they are used are as follows: To connect the main body with the sentries and with the outpost reserves; to transmit to the main body the information gathered by the patrol; for use in the cantonments; the connection of detached services over irregular ground, mountainous or wooded districts, etc. The judging of distances in shooting practice.

As these company lines are always established on peaceful territory, there is no need to suspend the wire, and it is simply unwound along the ground. The company apparatus has, therefore, been reduced to the simplest possible form by using wire 4-10 of a millimeter in diameter wound on a spool of small dimensions, and suppressing the bamboo rods.

Company Apparatus.—Two unwinding reels, 4 kilometers of wire (2 kilometers per reel), four magnetic telephones, three earth terminals, three telephone suspension hooks. The weight of the complete reel wound with 2 kilometers of wire is 2.5 kg.

Establishment of a Regimental Line (Fig. 3).—Suppose that a line of 6 kilometers is to be established: the corporal, or a supplementary operator, takes up his position at the point, a, placing his telephone to his ear, connecting it by one of his conductors with the lines, and by the other with his bayonet

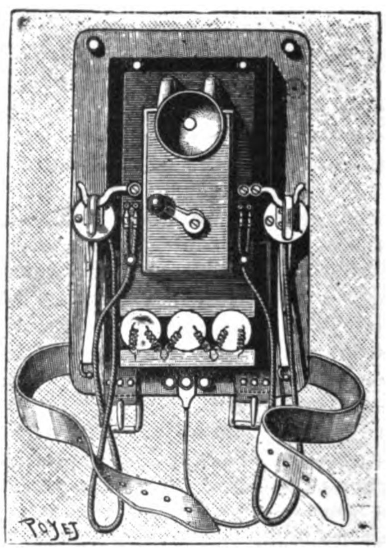


FIG. 2.—THE CHAROLLOIS ARMY TELEPHONE TRANSMITTER.

stuck in damp soil. The first set of men begin to unwind the wire. To do this, the bearer of the reel marches in the direction, b, at quick march, without troubling about the wire he leaves behind him. He takes care to march towards the supports to which the wire is to be hooked or suspended. His comrade, who is provided with the hooked rod, follows him, and hooks the wire to the natural supports that he finds on the way, trees, houses, hedges, etc. In default of natural supports, the wire is allowed to lie along the ground, preferably in furrows, trenches, etc.

[1] From "La Nature."

The line, whether suspended or lying on the ground, must be protected from any conditions likely to cause its breakage.

The first set of men having unwound their 2,000 metres, the

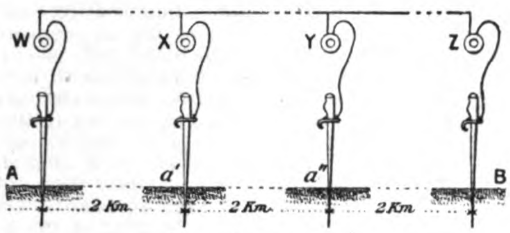


FIG. 3.

bearer of the telephone takes up his position at a', an intermediate post, as has already been done at point A, and at once enters into telephonic communication with his comrade at the head of the line. When the bearer of the rod for the first set has finished his work he holds himself in readiness to inspect the line, so as to find out and repair any accidental breakage that may have occurred, and that would be indicated by the cessation of communication. Thus these two men have the charge and superintendence of the portion of the line that they have laid down; they become, so to speak, the guards.

The second messenger, having attached his wire to the line, proceeds, as has already been explained, for the first. This operation is continued as far as B. The line of 6 kilometres will comprise four telephonic stations; two terminal ones at the ends of the line, A and B, and two intermediate, a' and a", for the inspection of the line. All these stations are in communication with one another.

This arrangement of the military line explains how unceasing surveillance can be exercised, how accidental breakages can be repaired, and, lastly, how it was that a line of 25 kilometres was able to be taken up in one hour during the Eastern maneuvers. The order having been given to all the stations at the same moment to take up the line, each set took up the line that they had laid down.

Communications with Operators on the March.—In this case the operator, with his left hand, keeps the sword bayonet connected with the telephone at his ear. The current is then permanently established, even during the march, through the body of the operator, and his feet which tread the soil. Every call from the main body is distinctly heard by the telephone operator or horse soldier, who stops and replies.

Employment by Cavalry.—This telephonic system can be of great service to cavalry regiments for the rapid conveyance of information gathered by reconnoitring parties and sentries.

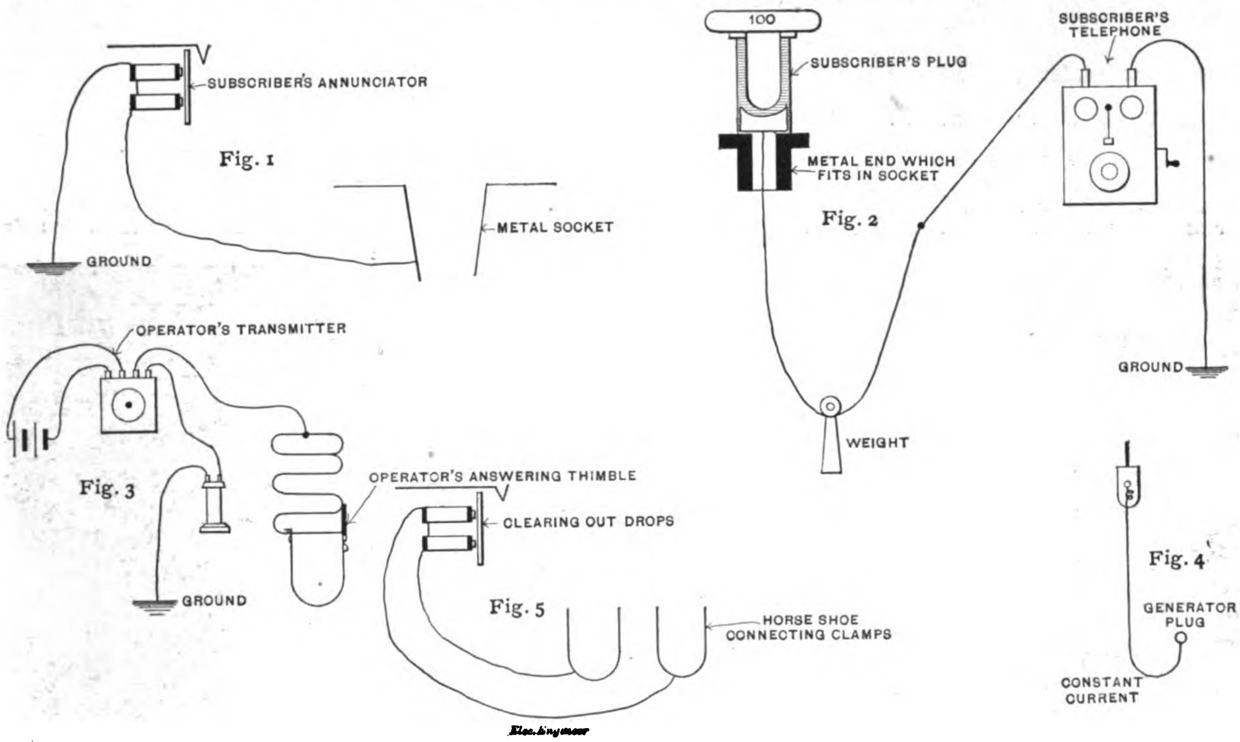
The modes of communication are the same as for the infantry. Nevertheless the horseman can, as described above for the foot soldier, be in constant communication, even when on the march, with headquarters. His telephone, which is at his ear, is in direct communication with the line by one of its conductors. The other conductor is connected with the bit, and consequently to earth through the body and shoes of the horse. If it should be necessary to establish a telephone line very quickly, the wire might be unwound by a cyclist. Extending the application of his naked wire system of telephony to everyday uses, Captain Charonnis has also constructed a series of instruments meeting ordinary requirements, and forming altogether a system of civil telephony that can be utilized in various ways.

THE SWARTS "MULTIPLE RIVAL" TELEPHONE SWITCHBOARD.

THE new telephone exchange recently put in operation at Knoxville, Tenn., is equipped with a type of multiple switchboard possessing a number of interesting features which conduce to rapidity of manipulation and in the arrangement of which special provision has been made for convenient handling by a smaller number of operators during the hours of few calls. This board, which is the invention of Mr. H. J. Swarts, manager of the People's Telephone and Telegraph Company, of Knoxville, Tenn., is a multiple board, and in its horizontal features recalls somewhat the old "Law" switchboard. In its details, however, it differs essentially from that type of construction. The engraving Fig. 6 shows the board in its normal position for the full force of day operators on duty in their respective positions. Fig. 7 shows the annunciator boards, which are adjustable, faced toward the table, carrying the subscriber's lines, this being their position for night and Sunday work when only a small force of operators is required.

As will be seen, the pegging table around which the annunciator boards are placed, is spaced into sections of 100 wires each, the arrangement being such that an operator at any section can reach to any subscriber wanted on any of the other sections, and make the connection for any of her subscribers without the assistance of any of the other operators and without moving from her seat. The engraving shows only six sections connected, each section being for one hundred lines; space is left to connect 400 more lines, which can be added as desired. When these are added the board will form a complete circle.

The diagrams, Figs. 1 to 5, show the circuit connections with



FIGS. 1 TO 5.—SWARTS TELEPHONE SWITCHBOARD.

the subscribers' line ending in a flexible cord, through metal socket to annunciator, and ground. It is obvious that in place of the plug, cord and socket there could be substituted a spring jack, using connecting cords and plugs in connection with the

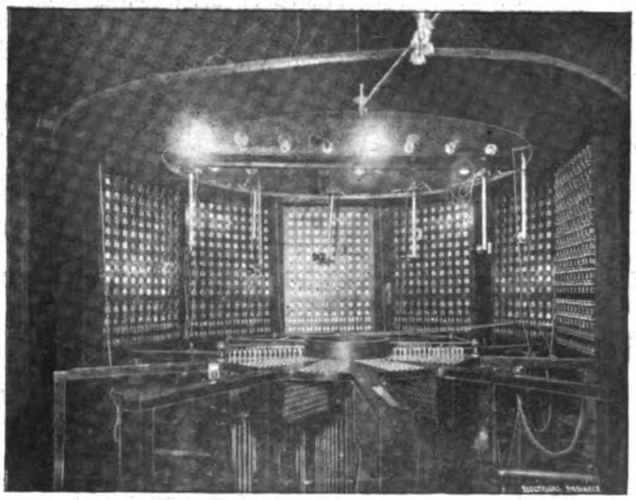


FIG. 7. THE SWARTS "MULTIPLE RIVAL" SWITCHBOARD.

spring jacks. In Fig. 1 is shown a line from socket to annunciator, thence to ground. Fig. 2 shows the subscriber's plug to subscriber's telephone. Fig. 3, the operator's transmitter, receiver and answering and listening thimble. Fig. 4, the generator plug. Fig. 5, the clearing out annunciators and connecting clamps.

The subscribers' plugs are numbered on top. With the line not in use, tne subscriber's plug rests with its metal in the socket, completing the circuit from telephone to ground through the annunciator. When the subscriber rings the operator lifts his plug from the socket, thus throwing out his annunciator, and presses the plug firmly between her thumb and finger, on which she wears the metal thimble that connects to the line post of her transmitter. This places her in connection with the calling subscriber, and, it wil. be noted, only one movement has been necessary to establish communication. As soon as the operator is told the number of the subscriber wanted she places the calling subscriber's plug into the connecting clamp, reaches and gets the cord or plug of the subscriber wanted and touches his plug against the generator plug and then places it into the connecting clamp that is a mate to the one where the calling subscriber has been placed. If any line is busy the fact is at once apparent; the plug of the busy subscriber being out of place and the cord drawn up through the socket, or, where spring jacks are used, a plug would be inserted. Mr. Swarts, the inventor of the board, makes the claim of being able to give a quicker service to an exchange up to 1,500 subscribers than can be given with any other switchboard, as there is no testing apparatus necessary to know if a line is busy, and only one-third of the amount of wire is necessary to wire up as required for the multiple board.

The board illustrated is designed for 1,000 subscribers, but can be made to accommodate 1,500 if necessary. It has been in operation for two months past in the new exchange of the People's Telephone and Telegraph Company, of Knoxville, with excellent results.

PACIFIC CABLE PLANS.

The United States Senate Committee on Foreign Relations on March 11 considered the two propositions before it provid'ng for the construction of a telegraphic cable from San Francisco to Japan, via the Island of Hawaii. No conclusion was reached by the committee, but it is believed that one of the two companies will be granted the right to construct the cable and be given a bonus by the government.

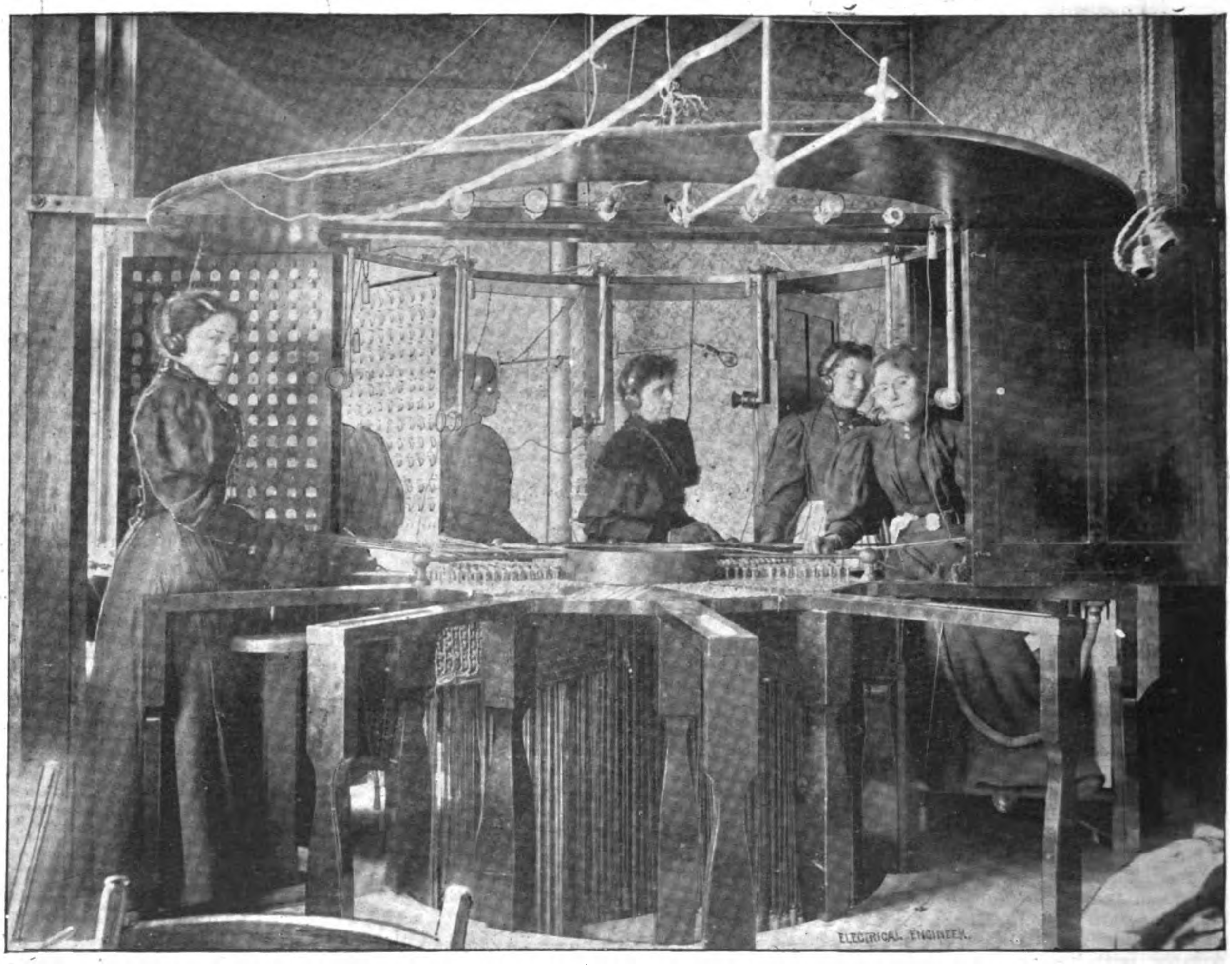


FIG. 6. THE SWARTS "MULTIPLE RIVAL" TELEPHONE SWITCHBOARD.

Power Transmission.

DISTRIBUTING POWER AND LIGHT FROM SINGLE PHASE ALTERNATORS.

BY JOSEPH N. MAHONEY.

It is the object of this paper to show a method of utilizing the present simple alternating apparatus for the generation and distribution of power and light by polyphase currents with no more complication than that met with in a three-wire direct current system.

It is a well-known fact that in this country outside of the large cities the large majority of the stations are operated with apparatus of the simple alternating, single-phase type, as is also the case on the other side.

The periodicity used in this country is from 125 to 150 cycles per second generally, but in the newer installations it ranges from 50 to 60, in England from 80 to 100, and on the continent from 40 to 60 cycles.

Up to the present time the art of building self-starting, single-phase induction or synchronous motors for commercial purposes has not progressed very far, and in consequence the usefulness of the plant has been limited to lighting work for a few hours each day.

In some cases direct continuous current power generators and circuits have been installed to distribute power at 500 volts during the day while the alternating machines and circuits are lying idle. For stations operating under the above conditions the writer would propose the following: First, let us consider the changes necessary in the station. It would be desirable in some cases to lower the periodicity of the generators to 50 or 75 cycles per second. This is done without impairing the efficiency or output by changing the polarity of part of the field coils and armature coils, thereby changing the number of active poles and also the periodicity. Any generator having a multiple of three or four poles can have the periodicity lowered to one-half or one-third of the present rate by this method.

It will not be necessary, in most cases, to lower the periodicity, and, in fact, it would not be desirable, as it would necessitate a change in transformers, as multiphase motors are being built that will work perfectly on circuits of 125 to 150 cycles per second.

The simplest and most flexible method of operating the generators will be found in the diagram at G, where two simple alternators are shown rigidly coupled mechanically to give two e. m. f.'s with a phase difference of 60 degrees, equal in effect to the e. m. f.'s of the generator of the so-called monocyclic system.

The generators need not necessarily be of the same size, the load being so distributed with regard to the two generators as to load them proportionately according to size, nor of the same make; but they must have the same periodicity and also the same speed, otherwise they would have to be geared to couple them rigidly, a belt connection allowing of a slip which probably would change the phase relation of the two machines.

Out of this connection can be had single phase monocyclic, diphase and triphase currents for operating motors and other translating devices requiring them. This is done with the aid of two suitably proportioned transformers, as shown in the diagram.

The handling of the generators will be practically the same as in the three-wire, direct current system with compound wound generators, the alternators being ordinarilly compounded and compensating automatically for the drop in potential occasioned by the resistance and reaction of the armature and line as the load varies on its side of the circuit.

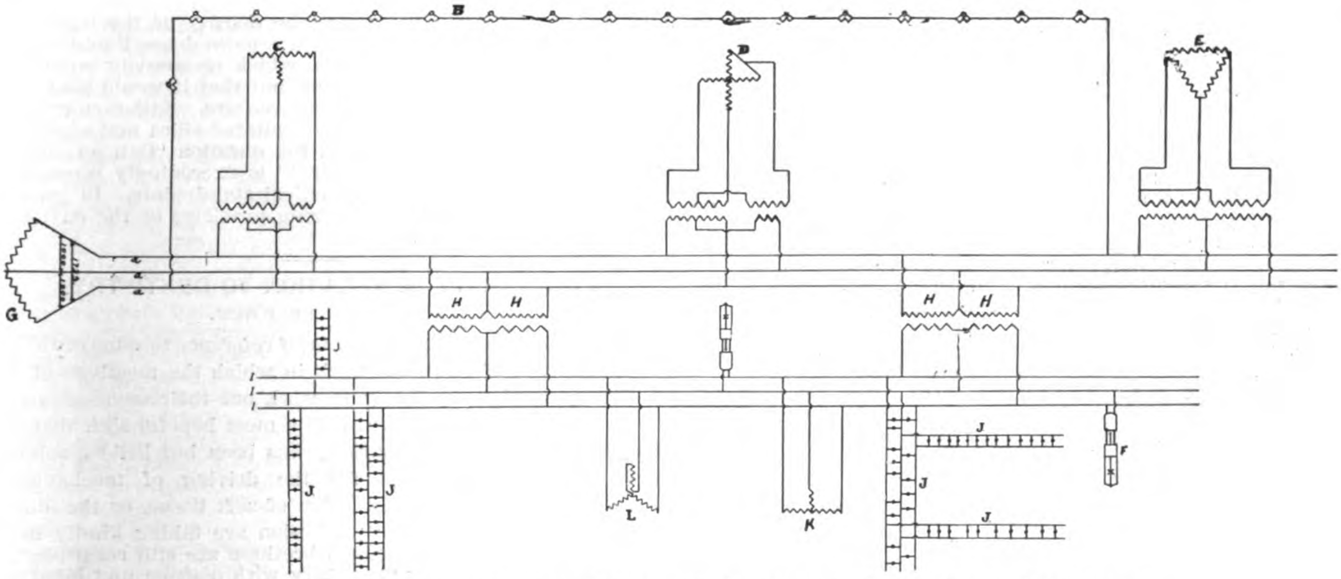
The line, and, in fact, the whole installation, would be relaid out as if it were to be a three-wire alternating current system, the only difference being that the generators, instead of being connected in straight series, would be connected in series with the slight phase difference of 60 degrees between the maxima of their e. m. f.'s. The e. m. f.'s impressed on the line would be, in the case of 1,000-volt generators, a mean difference in potential of a 1,000 volts between the neutral and either outer conductor and 1,733 volts between the outer conductors; and 3,466 instead of 4,000 volts in the case of 2,000-volt generators.

The secondary mains either overhead or underground would be operated from two transformers off the primary mains, the same as ordinary Edison three-wire mains, with the lamps connected between the outers and the neutral, and would have the advantage over ordinary three-wire alternating mains in that self-starting induction or synchronous motors could be operated therefrom without the intervention of any extra transformers, power wires, or apparatus other than that already contained in or on the motor.

These arrangements are shown in the diagram presented herewith. Here a, a, a are the mains or feeders leading from the station, to which are connected the circuit B, of either series incandescent or arc lights in parallel with reactive coils; C, a monocyclic motor in circuit with transformers; D, a diphase motor and phasing transformers; E, a triphase motor and phasing transformer. H, H, H, H, are large transformers feeding the secondary mains I I I, from which are operated the two and three-wire lamp circuits J J; the arc lamps F F with economy coils; tne monocyclic motor K, and the triphase motor L.

It will be seen that it makes a really flexible system of distribution with very little complications. The cost and bother of changing over would be nominal in most cases, as the only change necessary in the station is to shift the alternators so that they can be connected mechanically in pairs and driven from the engines or countershaft, as before.

The apparatus on the dynamo switchboard will be the same as if no change were made, each generator being regulated separately, the generator cables or bus' being connected electrically together after leaving the dynamo switchboard. The panels of the feeder board, if there be any, will be coupled up in pairs, each one of a pair controlling one side of a three-wire feeder. The present feeders and mains, consisting of two conductors, will be supplemented by third conductors of one-half the cross-section of either of the other conductors and we



Mahoney System of Distribution of Power and Light from Single Phase Alternators.

are at once able to transmit twice the power that we were before with only a 25 per cent. increase in copper. The transformers already installed will be connected between the small wire and either of the two larger wires instead of between the two large wires, as heretofore. Branches to transformers where only light is needed will consist of two wires only.

MISCELLANEOUS.

CAN AN ELECTRIC CIRCUIT BE OPENED WITHOUT AN ARC?

BY A. J. WURTS.

THE opening of an electric circuit is ordinarily accompanied by an arc which causes more or less damage to the switch terminals. The extent of this damage is in general dependent on the amount of current flowing and on certain characteristics of the circuit and generating apparatus.

Up to very recent times electric circuits have been handled with switches constructed without special reference to arcing, the deteriorating action of the arc not being sufficient to warrant special constructions. With modern lighting and power transmission circuits, however, the problem has assumed quite different proportions, so that, not only are ordinary switches rapidly destroyed in the handling of these circuits, but an element of danger is also introduced. To-day electric arcs six feet long are not uncommon.

While experimenting some time ago with static discharges I had occasion to pass a small discharge across a 1-32-inch gap, between electrodes which were placed in a heavy glass tube filled with oil and securely corked at either end. Much to my surprise, at the time, when the discharge occurred the glass tube was broken into small fragments; it did not burst as by an explosion; the tube simply fell to pieces. The experiment was repeated a number of times with the same result. I subsequently analyzed the experiment as follows:

An electric arc requires space. The glass tube was filled with an incompressible fluid possessing considerable inertia. An arc which might form within this fluid would be obliged to displace the fluid, which, in turn, being incompressible, would force out the walls of the containing vessel; the latter being brittle, were broken into fragments. The force which broke the vessel was the electromotive force which forced the arc across the spark gap. The elastic corks could not play the part of cushions and thereby save the tube, because the displacement of the oil was sudden—the oil was not pushed away by the arc, but knocked away, as with a hammer—and because the inertia of the oil between the arc and the corks was greater than that between the arc and the walls of the tube; in other words, the force became active in the direction of least inertia. Reasoning further, it seemed that if the vessel had been relatively stronger than the electromotive force, the arc could not have formed; in other words, it seemed as though the elements were at hand for the construction of a switch capable of opening an electric circuit without an arc.

Following out these ideas, I constructed an ordinary electric switch of about 100-amperes capacity, which was suitably located in a sealed cast iron vessel filled with oil. On placing this switch in a 500-volt direct current circuit, I opened and closed the switch some eight or ten times on 30 amperes and upon removing the stopper from the cast iron vessel was surprised to see the oil spurt. On examining the oil, I found it had been considerably carbonized. The accumulation of pressure and the carbonization of the oil indicated the formation of an arc at the switch terminals, which for a time puzzled me considerably, as the formation of an arc had not entered into my calculations. On repeating the experiment I neglected to replace the stopper, with the result that when the switch was opened a column of oil was forced into the air about six feet high. Testing again with the vessel closed I detected a slight gurgling sound when the switch was opened.

Being still puzzled, I determined to see what was going on within the vessel and had a heavy glass front constructed. Repeating the experiments, I noticed that on opening the circuit an arc was formed about the size of a pea. The same arc in air would have been about three inches long. After about a dozen breaks, however, the glass front was shattered, as though struck by a hammer. On further considering these results, it seemed to me that either the vessel had not been entirely filled with the oil or that the vessel was sufficiently elastic to allow the formation of the small arc noticed. It is not unlikely that both of these conjectures were true. However, the arc which actually formed was so insignificant that I felt encouraged and proceeded with my experiments, hoping to eventually produce results of practical value.

My first step was to overcome the pressure which accumulated, due to the formation of gases by the arc in the oil. I placed in connection with the containing vessel a small reservoir, having a direct pinhole communiction with the main vessel, also a valve connection allowing oil to pass from the reservoir into the main vessel by gravity. The pinhole communication was placed in a dome directly over the switch terminals, so that the gases which formed would rise to the top of the dome and pass out into the reservoir, which latter was only partially filled with oil. The pressure being thereby released in the switch chamber, sufficient oil would flow through the valve communication from the reservoir to occupy the space which had been previously occupied by the gas. This plan proving satisfactory, I proceeded to determine the life of the switch as compared with a similar switch used for the same purpose in the open air. After making about 3,000 breaks I found that the oil had carbonized to such an extent that with the switch open there was a current leakage of several amperes. Various oils were subsequently tried, some of which proved better than others. Of these paraffine oil gave the best results.

I next tried glycerine and with it made 40,000 breaks. At the end of this test the switch terminals were found to be slightly scarred, the glycerine was black from carbonization, but the current leakage was only a small fraction of an ampere on open circuit.

Having arrived at this point, I began to experience difficulty with the containing vessel, which now leaked badly in spite of the best fittings I could procure. To overcome this difficulty, I determined to increase the density of the liquid. It seemed to me that not only would a more dense liquid be less easily forced through the joints, which necessarily enter into the construction of the apparatus, but that it would also more effectually resist the formation of the arc. Satisfactory tests were made with a mixture of precipitated silica and glycerine.

Aside from the above results, the question "Can an electric circuit be opened without an arc?" is exceedingly interesting from theoretical as well as practical standpoints. In connection with the electrical engineering problems of the day, it is one of no small importance.

ELECTRICITY IN RELATION TO DENTISTRY.[1]

BY GEORGE HELI GUY.

I SHALL confine myself to a brief reference to some of the departments of electrical work in which the members of the dental profession are likely to work out their own salvation. In considering this question, it is a most hopeful sign that, although until recently, electricity has been but little employed in dental surgery, except for the driving of mechanisms, cauterization, the translumination of soft tissue, or the illumination of cavities, yet the profession are taking kindly to it. A large section of your medical brethren are still regarding its progress and increasing popularity with distrust and blind unbelief. Not long since, I asked a leading fashionable physician in New York his opinion as to the likelihood of electricity being eventually taken up in earnest by the profession. He replied: "It never will be. I have tried it myself, and have come to the conclusion that there is nothing in it." The whole electrical apparatus of this physician turned out to be a small faradic battery, and he had been treating all ailments with the same kind of current. There are thousands of practitioners who still think as he did. But there are many signs which go to show that the progressive and intelligent section of the dental profession are going with the times, and I was struck, and very much gratified, when attending the Dental Convention last year, at Asbury Park, to see the intense interest and appreciation with which the papers discussing electrical problems were received. I read not long ago of some electrical experiments upon floating organisms. If a galvanic current be passed through a bath containing paramecia in sufficient abundance, a curious sight is observed. When contact is made, the whole crowd of paramecia fall into order with their noses toward the cathode, and begin to swim toward it in converging curves; while, if the current be reversed, the crowd breaks up, all its units turn around and begin to swim away, as if of one mind, from the new anode to the new cathode. The creatures are evidently more "comfortable" when swimming with the electric current than the reverse way. In another experiment, a number of tadpoles were put into a lantern bath. They began to move about very leisurely, and to jostle

1. Abstract of response to toast of "The Coming Dentist Electrically Considered," at the annual dinner of the Central Dental Association, of Northern New Jersey, at Newark, N. J., Feb. 17, 1896.

each other in all directions. On sending a current of electricity through the bath there was prodigious excitement. As Dr. Waller, who conducted the experiment, described it, "The tadpole community seems to have gone mad; a writhing mass is all that can be distinguished; but the disturbance does not take long to subside, and now all the tadpoles are fixed as if at attention, heads to anode, viz., traversed by a current from head to tail, stroked down the right way." It appears to me that the dentists, like the tadpoles, have begun to find that it is wise to yield themseves to the current of electrical progress that has set in; it points their heads the right way, and means, in the long run, less trouble, better work, and last, but not least, relatively better pay.

One of the great drawbacks to the adoption of electricity in general dental practice is the cheap outfit and the poor installation work. Any man who can put up an electric bell now calls himself an electrician. If it were not for the inspection department of the Board of Underwriters, there would be, from bad wiring, such a crop of fires in large cities as would render the lighting of the streets entirely unnecessary. But there are no such adequate official restrictions and precautionary measures for the protection of the dentist. Beware of cheap outfits. Don't try to save a dollar or two in your battery plant; get the best that is in the market. Go, for your motors, and your dental equipment, to the best houses, that spend money on experimentation instead of letting you pay for it directly, and that insure careful inspection, and sound installation, and don't subject you to the curses of defective wires, poor plugs, and inferior tackle of every description. I know of an instance in New York, where the dentist had the hard luck to be taken in hand by a cheap, so-called electrician. Before he got through, he spent $500 in his electrical outfit, and then he threw it out and vowed he wouldn't have anything more to do with electricity, as it was a rank fraud. Therefore, I say dental electric outfits are like bicycles; if you want one to wear well, run smoothly, and save lurid language, get the best you can lay your hands on; you will get gratifying results, and you won't have any hard things to say about electricity.

Now, as to the electrical possibilities of the future in dentistry. Although we can't gauge them, we have been lately getting some glimmering as to the trend they are likely to take. I wish I could help saying something about cataphoresis; but I can't. The coming work in cataphoresis will not only be vast in extent, but marvelous in its general bearing on dental practice. Many occasions constantly arise where anaesthetic drugs may be introduced into tissue and into dentine, and also other drugs, such as iodine, etc., may be used in the same way, and their familiar topical effects be vastly enhanced by the aid of electricity. Few can comprehend the limitations of this great aid to the local application of drugs within the cavity of the mouth. Broadly, it may be said that any drug that has been previously used without electricity within the mouth to produce specific effect, may now be electrically used with tenfold its former power for good. The subject of cataphoresis is already very wide, and I am not going to enter further upon it. I would, however, say, as it leads up to another point, that the question of the resistance of the liquid used has a most important bearing in the therapeutical applications of cataphoresis. If the resistance is too high, as with chloroform, sulphuric ether, alcohol, glycerine, etc., little or no current is conveyed, and no cataphoresis takes place, while on the other hand, if the electric resistance is too low, as with strong saline and acid solutions, much current passes, but little or no cataphoric action takes place. Now, you are all familiar with the points of the late discussion on guaia-cocaine. It may be, and undoubtedly is, an excellent anaesthetic, but it is ill-smelling and escharotic, and none of you like it. It has been proposed to add almond oil to it, but if the resistance is thus increased, more current will have to be used. Dr. Morton, however, has found a way out of the difficulty. He says that guaiacol alone, and other similar substances and derivatives, in themselves non-conductors of electricity, by the addition of a very minute quantity of some innocent substance of an electrolytic nature, like; say, salts of caffeine or quinine, or any salts of the alkaloids, may be caused to penetrate tissue by the aid of electricity, and thus exhibit anaesthetic effects unobtainable without the aid of the added electrolyte. But this is one of the points that you gentlemen will have to straighten out before the best results from cataphoresis can be reached.

Further developments in the uses of the different kinds of currents is another subject which is too comprehensive to be discussed here. I may, however, promise that the sinusoidal current will sooner or later find its way into dental laboratories. As you know, a dynamo current is uneven, but the sinusoidal, with its very high vibrations, has soft, wave-like impulses; the current is agreeable and soothing to the patient, and more horse-power of electricity can be administered than if the frequency were lower and the wave less symmetrical. For example, the present sinusoidal machines run up to 2,000 alternations per second, whereas the alternations per second of an induction coil would be, probably, at their highest limit, 500 per second. Added to that, the graphic curve from the induction coil would be comparatively unsymmetrical, i. e., irregular. It is these two elements, the frequency and the graphic curve, or, as D'Arsonval calls it, "the characteristic of excitation," which determines whether the current is painful or not, and it is pain only, which limits the extent to which the induced currents from ordinary medical apparatus may be administered. On this head, I may mention, that guesswork in electrical dosage will soon be a thing of the past. The time is approaching when electricity will be prescribed and administered not only in measured units of intensity, density, and time, but with definite ideas of the electromotive force curve, and of the therapeutic indications that a given curve may be expected to fulfill.

There are many other branches of electrodental work in which we are on the verge of epoch-making improvements, and among them are the important ones of transiumination, implantation, and sterilization. For the purpose of transilumination, it is probable that more attention will be paid to the intensifying of the light. For instance, instead of confining the lamps for that purpose to small candle-powers, they might be run up to, say, 20-candle-power. Until lately, the difficulty has been that candle-power produced heat. This has been practically overcome by enclosing the first bulb in a second bulb through which water is made to flow. But here comes the fascinating question of the part which the phosphorescent, or "etheric" light, the "Tesla glow," or, as it is also called, "the light of the future," will play in transiumination. I had the pleasure about two years ago, of seeing, in Mr. Tesla's laboratory, a demonstration of the then newly developed phosphorescent light. The room was darkened, and electrostatic currents played into it at the rate of possibly a million vibrations a second. Vacuum tubes, in fancy shapes, lay all around, and as these were taken up and lifted into the "field" they burst forth into beautiful luminescence, and the room was illuminated. Tesla then prophesied that it would not be long before our houses were lighted without wires, and even without lamps, and that the night would be made as day by means of phosphorescent light caused by the play of current through air-exhausted tubes. Last year a photograph of Mr. Tesla was taken by this light. As a photograph it was not much to boast of, but as a piece of history, it was most interesting. It was the first time that a photograph had been taken by that light. That line of work was taken up by a man in your own city, Mr. D. McFarlan Moore, who in the short time that has since elapsed, has so developed it that he published a week or two ago, a bold and striking picture, possessing the clearness and strength of a daylight photograph, which was secured by a three-minute exposure under the new light in his laboratory. If such strides can be made in twelve months, and we are coming at such a rapid rate nearer to the electrican's—and, for the matter of that, the dentist's—ideal, of light without heat, I think it may pay the dentists to let their spirit of investigation drift in the direction of transiumination by phosphorescent light.

Electricity as an agent in implantation, etc., of teeth is a very attractive subject, and we are on the eve of great developments in this field, but I must not detain you longer.

There is, however, an incident which I should like to tell you of, which bears on another important branch of work, sterilization. Some time ago, a German physician wrote to Mr. Tesla and said that he had been experimenting with the play of etheric light on the bacilli of tuberculosis, and not only had he killed the microbes while experimenting, but he had by the same means cured tubercular developments in the human subject. This letter, sad to say, was burnt up in the fire at the laboratory, and Mr. Tesla has never been able to find where it came from. Now, gentlemen, you will see how beautifully this bears on the question of sterilization: pyorrhoea alveolaris should have no further terrors when it can be swept out of the human jaw with a brush of glowing phosphorescence, and a new charm will be given to dental work when light will not only illume, but purify and sterilize, and even kill the deadliest germs that work havoc within the soft tissue of the mouth.

And now, gentlemen, the Röntgen rays—no speech to-day is complete without something about them. I don't think any of us yet realize what they may mean to dentistry. If it can be established that the cathodic rays will, like light, kill microbes, you see at once where it carries you. There is one thing, however, that cathodic rays have done, that you gentlemen, I am sure, will take careful note of. They have passed through ivory, and photographed pieces of metal on the other side. Where fangs and other parts of the teeth are being treated, it is often necessary to know which teeth already con-

tain filling. There is now no further difficulty about this. As metallic substances intercept light to a greater degree than bone does, a cathodograph will show the location of all the filling in the teeth which have already been operated upon. Dr. W. J. Morton has proposed to put the Röntgen rays within the cavity of the mouth, and a sensitive plate within the plate holder outside on the cheek, and thus reproduce the teeth, in situ, fangs, filling, etc. In this connection, it would also be possible to determine the existence of ostitis, deformations, diseases of the bone, pus deposits, etc., in fact, the whole concealed pathology of the teeth in their relation to the jaw and gums would be thus revealed.

COPPER PRECIPITATION PLANT, AT BUTTE, MONTANA.

THE accompanying illustration gives a fair idea of the largest copper precipitating plant in America. It is located on the side hill just below the Anaconda mine and the water as it is pumped from the Anaconda and St. Lawrence mines is carried in a flume several hundred yards to a large number of vats into which all sorts of scrap iron and tin cans are placed. The average time required to precipitate the copper is about one month, and the output averages nearly 100 tons per month of copper.

COPPER PRECIPITATING PLANT AT BUTTE, MONT.

Copper in its pure state is very sparingly soluble in water, and in the chemical form in which it exists in the Butte ores (chiefly as copper pyrites and copper glance Cu_2S) not at all, and it is necessary that it should become a copper sulphate. In this condition it is readily soluble and can be leached out of the matrix and carried up out of the mine in the water. It is not definitely known how this change is brought about in the veins of ore, but it is no doubt due in a great measure to the the inflowing water, carrying more or less oxygen in suspension with carbonic acid gas. All chemical changes and combinations produce more or less heat, and this would tend to accelerate the change in the conditions of the ore, the carbonic acid gas also playing its part by reaction on both the ore and matrix.

The great fire in the St. Lawrence mine in 1889 has, and is now, producing the same chemical change in the ore body, and in the same way that we find taking place in the heaps of burning ore at the Rio Tinto mines, the heat aiding the chemical alteration in the ore mass, and hence its waters are very rich in the copper salt, the assay value of which will probably average one-half of one per cent. of the body of water coming out.

We have in this mine water, in solution, the copper salt of sulphate, i. e., sulphuric acid in combination with the metal, and since this acid has a much greater affinity for the metal iron than the first named, immediately the solution is brought into contact with it, the acid at once leaves the copper and combines with the iron, forming an iron salt or sulphate, which is very soluble in water and the copper is precipitated as the pure metal, mixed with some impurities only; the iron salt passing off with the water. The precipitation of the copper held in solution as a salt from the water pumped from the mines and otherwise, is not a new thing. It has been in operation for many centuries, notably at the great Rio Tinto copper mines in South Spain, and at the long worked mines on the Island of Anglesea, Wales, where immense quantities of old scrap iron are annually consumed.—"Western Mining World."

THEORIES OF ELECTROLYSIS.

In the current number of "Science Progress" Mr. C. Dampier Whetham summarizes existing theories of electrolysis. Starting with the application of Ohm's law to electrolytes, he discusses the evidence which Kohlrausch educed in regard to the specific character of ionic velocities. The hypotheses of Arrhenius, Ostwald and others concerning dissociated ions are next considered, and a number of interesting tables have been compiled by the author bearing upon the coefficient of ionization and constants of affinity of a number of electrolytes. The dependence of general physical properties, such as the osmotic pressure, freezing point, etc., upon the electrolytic characteristics of the liquid are discussed in relation to the researches of Mr. H. C. Jones on this subject. From established data, the author proceeds to summarize the hypothesis in regard to the dissociation accompanying the solution of highly stable solids. In regard to this branch of the subject he arrives by independent reasoning at the conclusions: "That pairs of opposite ions must be separated, and the ions exist free from each other's influence, and, secondly, that there must be a tendency towards the formation of more or less stable molecular aggregates between salt and solvent." The apparent contradiction involved in these two conclusions is got rid of by the fact that "since it is evident that one salt molecule can influence a large number of water molecules, it follows that the chemical forces are very far-reaching."

MR. G. N. SPENCER and others are interested in a plan for delivering power electrically in Los Angeles, over a distance of 108 miles.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS, ISSUED MARCH 10, 1896.

Accumulators:—

SECONDARY BATTERY PLATE. I. Samuels, New York, 556,027. Filed Sept. 10, 1894.

The negative element is in two equal portions and arranged on opposite sides of the positive element.

Alarms and Signals:—

BURGLAR ALARM. T. J. Sutton, New York, 555,982. Filed April 9, 1895.

A sliding rod between two arms, one end of which is adapted to operate a push pin and the other end to enter the keyhole of the door.

ELECTRIC SIGNALING SYSTEM FOR RAILWAYS. G. L. Thomas, Brooklyn, N. Y., 556,072. Filed June 11, 1895.

ELECTRIC BLOCK SYSTEM FOR RAILWAY CROSSINGS. A. E. Ellis, Boston, Mass., 556,139. Filed Nov. 8, 1895.

Automatically switches off the power current from certain sections of the electrical conductor running parallel with the tracks if the crossing ahead is not clear or safe.

ELECTRICALLY OPERATED RAILWAY GATE. B. Haberthue, Logansport, Ind., 556,183. Filed Oct. 15, 1894.

Dynamos and Motors:—

DYNAMO ELECTRIC MACHINE. W. M. Mordey, London, England, 555,963. Filed April 21, 1891.

A stationary non-magnetic armature having an annular series of coils and two series of rotating magnetic poles at opposite sides of said armature coils.

BRUSH FOR DYNAMO ELECTRIC MACHINES. F. J. & R. Chaplin, Birmingham, England, 556,176. Filed Dec. 10, 1895.

Consists of longitudinal wires crimped and grouped together into the required section.

Lighting:—

ELECTRIC CAR LIGHTING SYSTEM. A. H. Armstrong, Schenectady, N. Y., 556,079. Filed May 31, 1895.

A three-phase railway supply line, with motor-generator on the car for converting to continuous current, in connection with storage batteries.

Measurement:—

ELECTRIC METER. C. Wirt, Philadelphia, Pa., 555,992. Filed Nov. 30, 1894.

An electric oscillating motor for driving a register, and a cut-off controlled by a current indicator for cutting off the current to said motor at each oscillation, whereby the arc of vibration is made proportional to the current to be measured.

Miscellaneous:—

ELECTRIC GAS LIGHTING BURNER. J. A. & G. A. O'Neill, Boston, Mass., 555,968. Filed Nov. 16, 1895.

ELECTRIC ELEVATOR. H. R. Smith, Chicago, Ill., 555,979. Filed March 23, 1895.

A car, a hoisting cable therefor, a magnetic piece carried by said cable, a motor, comprising a solenoid, said magnetic piece forming the core of said solenoid, means for energizing various portions of said solenoid, whereby said core is moved and said car operated.

CAR COUPLING. C. Moradelli, Munich, Germany, 556,018. Filed June 16, 1895.

The car hoops are operated by magnets controlled from the locomotive.

ELECTROLYTIC APPARATUS. M. H. Wilson, Brooklyn, N. Y., 556,038. Filed May 8, 1895.

Employs a liquid electrode to prevent the disintegration of the anode.

PRESSURE RECORDING DEVICE. J. F. Batchelor, Brooklyn, N. Y., 556,081. Filed May 2, 1894.

A diaphragm operated by pressure, in combination with an electric time stamp.

PROCESS OF EXTRACTING NOBLE METALS FROM ORES. O. Frölich, Berlin, Germany, 556,092. Filed Aug. 3, 1895.

The metals are extracted from a lye containing 5 grains of each metal to the pint, using 12 amperes for each 2 square yards of cathode surface. This separates the gold.

ELECTRIC GAS IGNITER. J. P. Doyle, Buffalo, N. Y., 556,138. Filed Oct. 29, 1895.

A slotted gravity-cam hinged to the upper side of the bracket for vertically actuating the swinging electrode.

ELECTROTHERAPEUTIC BODY WEAR. G. Quarrie, Brooklyn., Mass., 556,161. Filed May 3, 1894.

A boot or shoe provided with a metallic insole having electrical connections through the sole of the shoe with the ground.

ELECTRIC GAS LIGHTING DEVICE. J. B. Jackson, Philadelphia, Pa., 556,189. Filed Aug. 15, 1895.

ELECTRIC CLOTH-CUTTING MACHINE. A. K. Thyll, New York, 556,224. Filed May 31, 1893.

Embodies an electric motor having two armatures, the field magnets of which extend in opposite directions and have three poles, one of which serves for both armatures of the motor.

Railways and Appliances:—

CONDUIT RAILWAY SYSTEM. O. A. Enholm, New York, 555,937. Filed June 15, 1895.

Employs yokes having traverse arms adapted to receive the rails, and laterally arranged plates in line with the conduit openings.

TRAVELING CONTACT DEVICE. M. D. Law, Washington, D. C., 555,958. Filed Sept. 28, 1894.

A trolley wheel, a pivoted arm for supporting the same; said trolley wheel being located vertically above the pivot and springs applied to lift the horizontal part and to maintain in upright position the vertical part of the arm.

UNDERGROUND TROLLEY. M. D. Law, Washington, D. C., 555,959. Filed May 9, 1895.

Relates to further details of the above.

RAIL BOND FOR ELECTRIC RAILWAYS. F. H. Daniels, Worcester, Mass., 556,046. Filed June 26, 1895.

The two terminals, each have a head of cylindrical shape, and are provided with an opening to receive the end of the bond wire or rod, and a cylindrical hollow portion adapted to extend through a hole in the rail, and to receive a drift pin.

ELECTRIC RAILWAY. H. C. Reagan, Jr., Philadelphia, Pa., 556,210. Filed Sept. 6, 1895.

A cable grip having electromagnet and contact devices mounted thereon, a feed-wire, a suitable conduit therefor, and contacts rotatably mounted on said feed-wire, the latter forming an axis for said contacts.

CLOSED CONDUIT ELECTRIC RAILWAY. E. R. Osmond, New York, 556,311. Filed Oct. 18, 1893.

Details relating to a switch for closing contact to the car circuit.

ELECTRIC SNOW PLOW. H. H. Kryger, Minneapolis, Minn., 556,315. Filed Sept. 10, 1891.

Details of construction adapting the same to be attached to a car.

ELECTRIC RAILWAY. E. M. Boynton, West Newbury, Mass., 556,320. Filed March 6, 1895.

Relates to the Boynton single-rail system with polyphase driving motor.

ELECTRIC UNDERGROUND TROLLEY RAILROAD. G. D. Burton, Boston, Mass., 556,321. Filed Dec. 21, 1895.

Relates to the handling of the trolley pole.

ELECTRIC RAILWAY. R. M. Hunter, Philadelphia, Pa., 556,322. Filed July 19, 1886.

A collector frame suspended from the axis of the vehicle and adapted to have lateral movement, traverse guides to prevent said frame from having longitudinal movement, a collector suspended from said frame, passing through the slot and making contact with the working conductor, and a conductor extending from the collector to the motor.

Switches, Cut-Outs, etc.

INSULATING SUPPORT FOR BOXES CONTAINING ELECTRICAL APPARATUS. T. H. Brady, New Britain, Conn., 555,922. Filed Jan. 4, 1896.

An insulated cut-out box. For description see "The Electrical Engineer," Feb. 19, 1896.

CIRCUIT BLOCK. D. A. Schutt, Peru, Ind., 556,028. Filed Nov. 16, 1895.

Consists of two or more sections of insulating material secured together by one or more metallic connections attached to each section, such metallic connections having electrical connection with main feed and branch wires, respectively.

SNAP SWITCH. A. B. Herrick, Bayonne, N. J., 556,185. Filed Nov. 23, 1895.

A main pivoted current carrying blade and co-operating contacts, a separated pivoted snap blade, beside the main blade in a different plane, and co-operating contact parts or surfaces for the snap blade out of the range of the main blade, and a spring connection between the main and snap blades.

ELECTRIC SWITCH. T. W. Gabel, Lancaster, Pa., 556,264. Filed May 13, 1895.

Adapted to dental work.

Telegraphs:—

INDIVIDUAL CALL SYSTEM FOR AUTOGRAPHIC TELEGRAPHS. H. Etheridge, Pittsburg, Pa., 555,938. Filed Feb. 1, 1892.

Consists of a revoluble shaft, a magnet co-operating therewith, and a clockwork mechanism connected to the paper feed-roll.

Telephones:—

SELECTING AND OPERATING TELEPHONES. H. L. Webb, New York, 555,984. Filed March 18, 1893.

A system of selective calling by varying impulses sent over the line.

AUTOMATIC TELEPHONE EXCHANGE SYSTEM. M. Freudenberg, Paris, France, 556,007. Filed Jan. 10, 1896.

The connections are made by travelers or carriages.

TELEPHONE SPEAKING TUBE SYSTEM. J. S. Stone, Boston, Mass., and G. K. Thompson, Malden, Mass., 556,034. Filed Sept. 28, 1895.

The several circuits, consisting of twisted pairs, are led through the several stations and normally open branches are led to terminals on the switching device at each station.

OBITUARY.

NATHANIEL W. PRATT.

Mr. Nathaniel W. Pratt, well known as an engineer and inventor, died on March 10 at his home in Brooklyn. He was born in Baltimore in 1852. His ancestors settled in Plymouth County, Mass., in 1630. The qualifications that made him a marked man in the world of mechanics were inherited from his father, William Pratt, who was a prominent engineer during the war.

Mr. Pratt was at one time consulting engineer to the Dynamite Gun Company, and from his designs and patents the first successful dynamite gun was built. It was with this gun that the first experiments in throwing aerial torpedoes were conducted at Fort Lafayette, New York Bay.

At the time of his death he was President of the Babcock & Wilcox Company, and a member of the American Society of Mechanical Engineers, American Institute of Mining Engineers, American Naval Institute, and the Engineers' Club, of New York City. His relations with the Babcock & Wilcox Company were always close, and his management of that large business was active and personal.

Mr. Pratt leaves an aged father and mother, a wife and three children.

Reports of Companies.

A PATENT LICENSING ARRANGEMENT BETWEEN THE WESTINGHOUSE AND GENERAL ELECTRIC COMPANIES.

THE subjoined announcement is made with regard to an agreement effected on March 12 in this city between the General Electric and Westinghouse Companies, as to the use of each other's patents:

"Negotiations between the General Electric Company and the Westinghouse Electric and Manufacturing Company have resulted in an arrangement with respect to a joint use of the patents of the two companies, subject to existing licenses, on terms which are considered mutually advantageous.

"It has been agreed that after certain exclusions the General Electric Company has contribtued 62½ per cent. and the Westinghouse Electric and Manufacturing Co. 37½ per cent. in value of the combined patents, and each company is licensed to use the patents of the other company, except as to the matters excluded, each paying a royalty for any use of the combined patents in excess of the value of its contribution to the patents.

"The patents are to be managed by a board of control, consisting of five members, two appointed by each company, and a fifth elected by the four so appointed. Both companies have acquired during their existence a large number of valuable patents and numerous suits have been instituted in consequence of the infringement of these patents by one party or the other, or by their customers. In the prosecution of these suits large sums of money have been expended and the general expenses of the companies have in this manner been greatly increased. It is expected that the economies to be effected will be very considerable and that the two companies and their customers will be mutually protected.

"The especial incentives which led to the arrangement at this time were the recent decisions in favor of patents of the General Electric Company controlling the overhead system of electric railways, the approaching trials on a number of other important General Electric patents on controllers and details of electric railway apparatus and systems and other electricial devices, and the equally strong position of the Westinghouse Company in respect to power transmission, covered by the patents of Nikola Tesla, and in view of its other patents in active litigation, some of which are of controlling importance."

It will be remembered that similar negotiations were begun many months ago, were denied, broken off, and apparently dropped. That steps to effect such a policy were being taken, however, was understood to be the fact, and rumors were current that auhorized discussion of the subject had begun.

Duer, Strong & Jarvis, of No. 50 Wall street, have advertised for stockholders of the General Electric Company, who are not satisfied with the management of President Coffin to confer with them. It is reported that the action is instigated by stockholders of the old Edison General Electric Company, which was absorbed by the General Electric Company.

The General Electric Company was organized April 15, 1892, under the laws of New York, and acquired all of the stocks of the Edison Electric Light, the Edison General Electric, Thomson-Houston Electric and the Thomson-Houston International Electric companies. The total authorized capital stock is $50,000,000, of which $34,712,000 has been issued, $30,460,000 of which is common, and $4,252,000 preferred stock. There are $8,750,000 5 per cent. debenture bonds outstanding. The company paid dividends until August, 1893. No dividends have been paid since that time. Money is said to be in hand to pay a dividend on the preferred stock. The company owns manufacturing plants in Lynn, Mass., and Schenectady, N. Y.

The Westinghouse Electric and Manufacturing Company was organized under the laws of Pennsylvania in 1891. It owns a factory plant near the City of Pittsburg, Pa., and operates, under various agreements, the factories of the United States Electric Lighting Company at Newark, N. J., and of the Consolidated Electric Light Company in this city in the name of the Sawyer-Mann Electric Company. The capital stock is $10,000,000, of which $9,852,300 is preferred and $147,700 common stock outstanding.

The men employed directly by these two companies number about 12,000.

With regard to the effect on Wall street, the New York "Journal" of March 13 tells the following yarn: "While the directors of the two companies were in session yesterday afternoon a scoop was engineered in order to let in a number of outsiders who had not been informed of the certain success of the deal. The stock was broken from 38 to 36¼ in a few minutes on a report that the meeting of the Westinghouse directors had broken up in a row and all negotiations were off. Traders and outside speculators were frightened and threw overboard their holdings in the belief that the deal was off. Nearly 15,000 shares of stock were in this way liquidated by deluded holders and promptly grabbed by brokers for the insiders. So heavy was this liquidation that even the extraordinary buying demand only advanced the stock 1⅛ per cent. to 37⅜, at which price the stock closed. This was a net decline of ⅛ per cent. for the day. After the close of the market the speculators who had been scared out of their holdings discovered their error, and there was a scouring of offices to secure the stock. Before 4 o'clock the stock was 38½ bid on the curb, but few offers were made under 40, and it was doubtful whether 5,000 shares could be secured at that price."

THE AMERICAN ELECTRIC HEATING CORPORATION. —A NEW CONSOLIDATION.

After six months of negotiation the absorption of all the important electric heating companies has been effected by the American Electric Heating Corporation, head office at Sears Building, Boston, and the control of the new consolidation will pass into the hands of a syndicate including Charles A. Morss, Wm. Endicott, Jr., Charles E. Perkins, Charles J. Paine, Oliver Ames, E. S. Converse, C. C. Converse, E. L. Corning, Thomas Nelson, E. N. Fenno, A. R. Whittier, Jackson & Curtis, E. D. Barbour, Robert Bradley, Peter Bradley, Robert Treat Paine, Jr., and others.

The new Board of Directors will consist of J. Murray Forbes, President; Charles A. Morss, Jr., Edward C. Perkins; Charles L. Edgar, of the Edison Electric Light Company; Charles Francis Adams, 2d; Everett Morss, Arthur B. Smith, Geo. U. Crocker, Ambrose Eastman, of Boston; S. S. Wheeler, of the Crocker-Wheeler Electric Company, and Arthur M. Dodge, of New York, and H. B. Scott, of Burlington, Iowa.

The concerns absorbed by the American Company are: The Western Electric Heating Company, St. Paul, Minn.; the Central Electric Heating Company, of New York; the New England Electric Heating Company, the Burton Electric Company, Richmond, Va.; the Carpenter Electric Heating Manufacturing Company, St. Paul, Minn.; the Dewey Electric Heating Company, Syracuse, N. Y.; the Rich Electric Heating Company, Mount Vernon, N. Y., as well as several others which have not been active in the business for some time, but which owned valuable patents.

Heating by electricity is now a commercial success, and in addition to the large number of patents now owned by the American corporation it also owns patents covering the enamel process, which has already proved of great value in rheostats, and it is believed will be of equal importance in many other devices.

The opportunity for the application of electric heating in industrial establishments is very large, and recognizing this, the company has established a laboratory for special work, which will enable it to care for this class of business in an intelligent and satisfactory manner. The line of cooking devices now on the market, as well as other domestic appliances, such as small stoves, laundry and tailors' irons, etc., is quite complete, and a considerable business is being done. During the past season many thousand car heaters were sold by the company. While much of the product has been very satisfactory, that which is not so will receive immediate attention, and several improvements are in hand which will prove to be desirable additions. This especially applies to cooking apparatus, car heaters and special industrial devices.

The slow progress heretofore made in electric heating has not been owing so much to difficulty in perfecting devices as to want of concentration of patent rights and management, and to insufficient capital. The policy of this company is to furnish the best that the state of the art will permit, and they are provided with an able corps of practical men to insure this. They begin business with ample capital and with a list of stockholders and a Board of Directors, composed of substantial and conservative business men, and including some of the foremost electrical engineers in the country.

The manufacturing will be concentrated at Cambridge port, and the head office is at 611 Sears Building, with agencies in New York and Chicago. Mr. James I. Ayer, ex-President of the National Electric Light Association, is the General Manager.

THE PADUCAH ELECTRIC COMPANY, Paducah, Ky., is in the market for a water tube boiler of 150 to 250-horse-power capacity.

LEGAL NOTES.

IMPORTANT DECISION IN FAVOR OF STIERINGER AS TO COMBINATION FIXTURES.

GEORGE MAITLAND VS. ARCHER & PANCOAST CO.—U. S. CIRCUIT COURT, SOUTHERN DIST. N. Y.

THIS was a final hearing in equity before Judge Coxe. The action is founded on Reissued Leters Patent, No. 11,478 granted March 12, 1895, to Luther Stieringer, assignor to complainant, for an improvement in electrical fixtures. The original, No. 259,235, was dated June 6, 1882, and was applied for March 15, 1882.

Claims 1, 7, 8, and 9 of the original were before the court in the Eastern District of Pennsylvania in Maitland vs. Gibson, 63 Fed. Rep., 126, and were held to be invalid.

The decision of the Circuit Court was affirmed by the Circuit Court of Appeals for the Third Circuit upon the opinion of the Circuit Judge (Id., 840).

The first claim of the or.ginal patent was as follows: "A fixture for electric lights, supported from the piping of a house, and electrically insulated therefrom, substantially as set forth." The court held that this claim contained three elements. First, a fixture for electric lights; second, the piping of a house, and, third, means for electrically insulating the fixtures from the piping. That the third element included every kind of insulating device by which two conducting bodies may be mechanically united and yet electrically separated, and that the claim was too broad, and therefore void. Claims 7, 8, and 9 were held to be subsidiary and void, as mere aggregations plainly obvious to the skilled workman.

The complainant construed the decision as awarding him the insulating joint if limited to the precise combination shown, and upon this theory applied for the reissue. So far as relates to the present controversy, the object of the patentee, as stated in the specification, was to utilize the support afforded by the gas pipe of a house for sustaining metallic fixtures for electric lighting containing insulating conducting wires so arranged that the proper connections can be cheaply and conveniently made. He accomplishes this object by carrying the conducting wire from the ceiling, by proper connections, down through the main stem and arms of the chandelier, which may be used also for gas lighting, and is provided with two or more arms and an ornamental shell which hides the wires and connections from view. At the upper end of the chandelier is an insulated joint which separates the chandelier electrically from the grounded piping of the house. The electrical insulation of the fixture from the supporting pipe is as applicable to wall brackets as to chandeliers.

In the course of his decision, Judge Coxe says: A study of this record has convinced me that Stieringer was the first to make the use of gas chandeliers a practical success in the art of electric lighting. The prior structures were not only dangerous, but awkward and ungainly. Stieringer's is absolutely safe, and, at the same time, the symmetry and graceful contour of the fixture is preserved. When the conditions surrounding the genesis of electric lighting are remembered it can hardly be denied that the man who yoked the new art to the old, and fully developed the art of electric lighting was something more than a mechanic.

It is plain that he who utilized for electric lighting the expensive and intricate gas pipe systems then existing and the fixtures which embodied a multitude of graceful designs took a long forward step. He made electric lighting cheap, convenient, simple, and safe. Of course it is not pretended that Stieringer was the first to use gas piping and fixtures in this art, but it is thought that he was the first to make the use of an internally wired metal fixture absolutely safe. If any one did this before Stieringer the record does not disclose his name.

The defendant hardly does justice to Stieringer's achievement when it is asserted that it involved merely the uses of an insulating joint. Grant that with the idea of putting insulation at the ceiling joint of an internally wired fixture clearly before him, it required nothing but ordinary skill for the workmen to carry out the idea, can it be said that it required no exercise of the inventive faculties to conceive and carry out the idea? A number of accomplished inventors were at work on this very problem. They accomplished nothing. Stieringer succeeded. His combination is in use to-day precisely as he embodied it. There have been some incidental mechanical changes, but the substance is the same. It is not an unreasonable presumption that one who succeeds in doing what so accomplished an inventor as Edison failed to do, is on a distinctly higher plane than a mechanic. Not only did Edison fail himself, but he was among the first to recognize the merits of the invention practically as well as theoretically, for his firm took a license under Stieringer's patent. So did the defendant in the Pennsylvania case, the defendant in this case, and afterwards, substantially, the entire art. The importance of the patent was conceded and acquiescence was well-nigh universal.

All this is wholly inconsistent with the theory that the patentee's contribution was perfectly obvious and without patentable merit. The history of the art from 1882 is a refutation of this proposition. Stieringer's joint, located at the ceiling, seems to be regarded as one of the absolutely essential features where an internally wired metal fixture is used. If not essential, why should the defendant and all other manufacturers be so strenuous about its use? They can omit it, or locate it elsewhere in the system with perfect impunity.

It is not pretended that any of the prior patents anticipates; many of them, though relating generally to electric lighting, do not deal with the heavy and dangerous currents from the dynamo, but with feeble currents in branches of the art entirely distinct from the one now under consideration. Aggregated they would not show a skilled workman how to utilize the existing gas fixture.

The ferryboat exhibit is unquestionably the best of the defendant's references.

Irrespective of the question whether it was prior to the conception of Stieringer's invention, and of this there is grave doubt, it is thought that it can only be regarded in the light of an experiment that was tried, proved to be an utter failure, and was abandoned.

If his had been the only contribution to the art, electric lighting, in the particulars mentioned, would not have advanced a step. It was dangerous and inefficient. It accomplished nothing. After a trial of two or three months it was abandoned. During this time the joints leaked gas and broke in two. The chandelier was held by the wires alone, and was in danger of dropping on the heads of the passengers. Some of the very dangers which Stieringer sought to avoid were inherent in this structure.

Perhaps its principal vice was the employment of the metal of the chandelier as part of the conducting circuit. It was a one-wire system. The witness who wired the fixture and who was then a machinist and is now a butcher, describes it fully and accurately. He says, among other things, that it was wired "partly inside and partly out. One wire was inside from the ball joint at the top, the ground wire was soldered onto the pipe; it came through the upper deck overhead and was soldered just below the insulating joint, and that ended it. The other wire ran alongside the pipe and inside the casing from the wooden canopy down to this other wooden ball and then out through and around the wooden ball and then the branch wires were soldered onto the main wire down to the lamp." It is not surprising that such a structure was a complete illustration of "how not to do it." It was an embodiment of irredeemable inefficiency. Short circuits were formed, a wire would ground on the gas pipe and the lights would go out. The pipe was burned, a hole was burned through the brass canopy, the wires were burned off in the tubing and the joints were wholly inadequate. The structure proved an utter failure; the joints were discarded and the wires placed on the outside.

A meritorious invention should not be defeated upon such proof. In fact, the ferryboat fixture is an indirect tribute to the value of Stieringer's invention. It exhibits the kind of work to be expected of a skilled mechanic, even after the insulating joints were placed in his hands. The mechanic failed. The inventor succeeded. In short, I cannot resist the conclusion that Stieringer made an invention of considerable merit, and, this being so, the court, of course, is anxious to give him protection commensurate with his achievement. To confine the invention to some specific form of joint is, as before stated, tantamount to saying that the inventor has done nothing at all. He was not working to improve an insulating joint. He was working to improve the art of electric lighting by cutting off electrically the piping of the ceiling from the metal of the chandelier. To do this he required an insulating joint, to be sure, but it was only one of the elements which, when inserted at the ceiling, made the combination successful. It was this conception which made the valuable contribution to the art. The shops might have been full for years of joints of this character and the art would not have progressed a step. What did advance the art was placing a joint having these characteristics at the ceiling in the manner described. When that was done a combination was created where every element acts upon every other and all are necessary to produce the desired result; in short, a combination having the "per my et per tout" characteristics.

The only other question relates to the reissue. Still confining the discussion to the first claim it seems too plain for ar-

gument that it is much narrower than the first claim of the original. None of the limitations above referred to is in the latter. The claim of the reissue is fully sustained by the original specification and drawings. As soon as the complainant was informed by the final decision of the court that his claim was too broad he applied for a reissue limiting it to what he thought the court had left in his possession. Of course, no structure would infringe the claim under consideration that would not infringe the broad claim of the original, and no intervening equities have arisen. In such circumstances I know of no authority compelling a ruling that the reissue is void.

It follows that as to the first claim of the reissue the complainant is entitled to the usual decree.

In this case Hector T. Fenton appeared for the defendant and R. N. Dyer and D. H. Driscoll for the complainant.

Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

THE IRON CLAD RHEOSTATS.

One of the essential adjuncts to every electric generating or motor plant is the regulating apparatus, and among this the rheostat plays a most important part. The improvements which have been effected in this detail during the last few

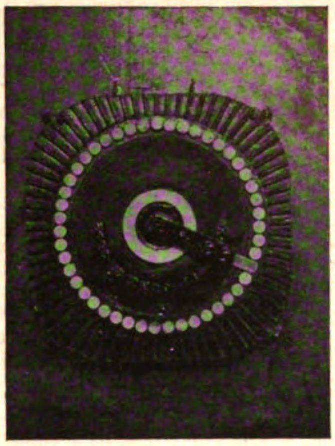


FIG. 1.

FIG. 2.

years have been most striking and resulted not only in increased efficiency and reduction in space required, but in cost as well. Among this class of apparatus the "iron clad" rheostat, manufactured by the Iron Clad Rheostat Company, of Westfield, N. J., has steadily increased in use, and the new

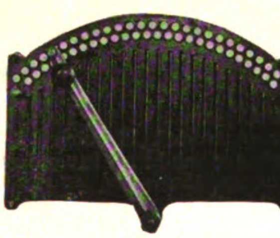


FIG. 3.

price list embodied in the company's advertisement in this issue indicates the extent and variety of their work. We illustrate herewith a few of their more prominent products.

Fig. 1 illustrates a field rheostat arranged to be mounted on the rear of the switchboard; Fig. 2 shows it in side elevation; the same plates are furnished for mounting on the face of the switchboard, one of this type being shown in Fig. 3.

Among the variety of motor starting and motor regulating rheostats we illustrate those shown in Figs. 4 and 5.

The Iron Clad Rheostat Company manufacture a most complete line of these rheostats, and also make a specialty of building feeder equalizers, regulators to be used in connection with storage batteries, special instruments for the use of surgeons and dentists for cautery work, and also rheostats to be used in connection with galvanic, and faradic batteries.

These rheostats are made on the well-known principle of using a large metal surface for radiating the power dissipated in small resistance conductors. The conductors are imbedded in an insulating material attached to the cast iron plate.

The process by which these rheostats are made allows for

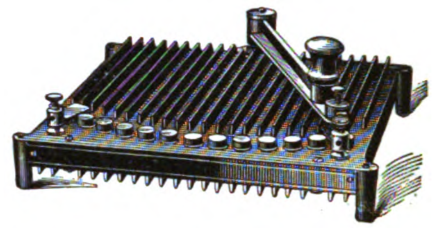


FIG. 4.

the difference in expansion in the materials used without danger of disintegration of the plate.

In September, 1895, the company built a commodious factory

FIG. 5.

at Westfield, N. J., to accommodate their growing business, and since then their business has so increased that they are now discussing an extension to the factory.

THE WIRING OF ELECTRIC CARS.

The Interior Conduit and Insulation Company has just issued a circular to street railway companies, of which we print the body below:

We take the liberty of addressing you upon the subject of the Wiring of Railroad Cars for electric lighting and power. The system we are promoting relieves you from all the annoyance, discredit and dangers attendant upon the past methods of wiring, and instantly commends itself to railroad companies, car builders and electrical engineers on account of its simplicity, durability and economy. Our method consists of a system of insulating waterproof and electrically fireproof tubes which may be concealed in the framework of cars after the manner of gaspipes. These tubes are run from roof of car to motors, controllers and all lamp outlets in the car, thus making a complete insulated raceway for all wires. The dangers resulting from the accidental overheating, or perhaps melting of wires, and the consequent liability to destruction from fire, is completely eliminated by the use of our system. The wires are perfectly accessible at all times, and in the event of the failure of any circuit from any electrical derangement the defective wire may be withdrawn and a new one substituted in its place without removing the woodwork or defacing the interior finish of car. The system we offer you insures absolute immunity from fire, accessibility to concealed wires, durability of insulation, reliability and economy. We manufacture insulating conduits, protected by either brass or iron armor, and mail you samples of both under separate cover.

THE BIMETALLIC ELECTRIC TRANSMISSION COMPANY, 1204 Havemeyer Building, has issued a neat circular on its specialty, the front and back covers being printed in bronze, so as to show the steel core in its copper sheath. There is a loose sheet giving sizes, weights and strengths, and the text describes the various uses in each branch of electricity, to which the bimetallic wire can be advantageously put. The wire is beautifully made—a choice example of the wiredrawer's highest art.

MR. THOMAS R. TALTAVALL, who for the past six years has been editor and part owner of the "Electrical Age" of this city, has sold out his interest in that journal and resigned as its editor, his resignation taking effect last Saturday.

PROFESSOR ROENTGEN has been created a baron of the Kingdom of Bavaria, in which State the University of Wurzburg is situated.

Department News Items will be found in advertising pages.

THE

Electrical Engineer.

Vol. XXI. MARCH 25, 1896. No. 412.

ELECTRIC LIGHTING.

EXPERIMENTS WITH ROENTGEN RAYS.

BY

Thomas A. Edison.

WELL crystallized tungstate of calcium made by the fusion process is extremely sensitive to the Röntgen ray. If the ray varies as the square of the distance, as there is every experimental reason to think it does, the tungsten salt is six times more sensitive to the ray than platino-barium cyanide. Plates of hard calendered pasteboard covered with the crystals permit, with a good tube, the seeing of all of the bones of the hand and arm. The fingers can be seen moving through eight inches of wood.

The next best fluorescing salt is tungstate of strontium, made in the same manner. Tungstate of barium or lead does not appreciably fluoresce. Knowing that the ray is absorbed by metals of great atomic weight, it would be natural to suppose the tungsten salts would fluoresce, and that it would be necessary to use a salt of a heavy metal, or one of great atomic complexity, but this is not true, as salicylate of ammonia crystals fluoresce with about the same power as platino-barium cyanide. The salicylate of ammonia crystals have this peculiarity that the fluorescence increases when the plate is covered more thickly with crystals, the maximum sensitiveness is reached when looking through ¼ of an inch of loose crystals. This would show high fluorescent power with low absorption.

There are a number of other salts and minerals which fluoresce. The following is a list: Subchloride of mercury, mercury diphenyl, cadmium iodide, sulphide calcium, potassium bromide, tetrametaphosphate of lead, potassium iodide, mercurous chloride, bromide lead, sulphate lead, fluorite, powdered lead glass, pectolite, sodium cressotinate, ammonia salicylate, calcium salicylate, salicylic acid.

The following are salts which fluoresce less: Powdered German glass, barium fluoride, calcium fluoride, sodium fluoride, sodium chloride, mercuric chloride, cadmium chloride, silver chloride, lead chloride, lead iodide, sodium bromide, cadmium, lithia bromide, mercury, cadium sulphate, uranium sulphate, uranium phosphate, uranium nitrate, uranium acetate, molybdic acid, silicate of potash dry, sodium bromide, wulfenite, orthoclase andalucite, herdinite, pyromorphite, apatite, calcite, danburite, calcium carbonate, strontium acetate, sodium tartrate, barium sulphobenzoic, calcium iodide, true and artificial ammonium benzoic.

It is anomalous that rock salt being practically transparent to radiant light and heat, should powerfully absorb the X-ray and give strong fluorescence.

I have found with a thick cube of fluorite, which is transparent like glass, that it fluoresces strongly to the ray, and accumulates, getting brighter and brighter; after the bulb is disconnected it continues to fluoresce for several minutes. I have not noticed this in any other substance, except slightly in thick layers of calcium tungstate. If the hand is held before a box containing the fluorite plate, the shadow of the same may be seen phosphorescing for a minute or two after the current has been disconnected from the tube.

A curious phenomenon occurs in tubes which are best adopted for the X-ray. After obtaining a high vacuum on the pump, where the line spectrum disappears and pure fluorescence and the X-ray is strongest, the lamp is sealed off. In a short time, varying with the different lamps from one to three hours, the vacuum becomes poor. All the phenomena of low vacuum take place in light and the vacuum is really low, as ascertained by experiments while on the pump. If now the tube be kept in connection with the current it will gradually go through all the changes to a high vacuum, the line spectrum will disappear suddenly and X-rays will appear. If the bulb be left for 24 hours it requires 4½ hours continuous connection with the current to bring it back to the X-ray stage. Eighty per cent. of the lamps act in this manner; it is independent of the kind of glass and of many variations made in the pump; it occurs with, or without, phosphoric anhydride. It would seem that the effect was due to atomic electrolysis, free atoms being disconnected with the ether, only molecules being connected so as to produce pressure on the walls of the tube.

Another experiment in connection with vacuum tubes is worth recording. Edlund's theory, which has not yet been refuted experimentally, is that a vacuum is a perfect conductor of electricity. As it has been found that the resistance of any tube but slightly changes when the distance between the electrodes is increased and that the whole of the resistance is at the electrodes; also that when the vacuum is so high that no spark can be forced through it, it is easily made luminous by external electrodes, there being none in the glass. In the course of my experiments I obtained a very high vacuum through which a 12-inch spark with Leyden jars could not be forced; neither could any conduction take place with external electrodes. The tube was always dark.

It has been stated that aluminum and magnesium electrodes do not deposit on the glass. In the case of magnesium, by several hours' sparking there is formed a magnesium mirror, of lavender color by transmitted light. In the case of aluminum there is apparently no deposit. Mr. Dally, my glassblower, by oxidizing the surface of a broken tube found that the layer of aluminum was transparent and only appeared when oxidized to aluminum oxide, which was so thick that objects could not be seen through it.

I am continuing my investigations in this direction.

ROENTGEN RAYS "ANODIC" NOT "CATHODIC."

BY

Elihu Thomson

SINCE the first publications concerning Röntgen's discovery of the rays emanating from a Crookes tube it seems to have been assumed by most investigators that said rays have some relation to the radiant matter of Crookes which is a phenomenon of the cathodic terminal.

Others, again, have considered that the rays discovered by Röntgen were produced at the glass surface, or during transmission through the glass and as a consequence of the impingement of the cathode rays upon the glass, causing its fluorescence. Professor J. J. Thomson is reported to have exposed photographic plates to the cathode rays or radiant matter within the tube without having produced any effect which could be brought out by development.

Very recently Professor H. A. Rowland has pointed out the fact that the Röntgen rays are emitted from the anode and not from the cathode, and this view, coming from so high an authority, is in itself an indication of its probable truth. The writer, personally, had been led to suspect that the rays were anodic, not cathodic; for it was found that the rays when traced to their source within the tube by methods which have been published by him, came from that terminal which, during the passage of the spark discharges, could not have been the cathode. Using a Wimshurst machine, it was easy to determine the polarities. Furthermore, the best effects on the photographic plates were produced opposite that portion of the glass which became strongly fluorescent. This fluorescence, however, could not have been produced from the cathode, as the rays normal to the cathode surface would not have impinged there.

By constructing a dark tube with a screen of barium platino-

cyanide the writer was able to submit to examination the various forms of Crookes tubes in his possession. Some of these, though fluorescing strongly by the cathode rays, gave at no position with respect to the screen tube any indications of the emission of Röntgen rays, while some gave feeble indications near the anode, and in exceptional instances a strong effect was noted, not from those parts where the cathode rays made the glass fluorescent, but from other parts opposite the anode.

The crucial test was made by placing a small patch of opaque metal upon the side of a tube opposite the anode. It was found that when the anode, the patch, and the fluorescent screen were in line, no fluorescence was obtained, although the screen was fully exposed, as it were, to the cathode.

It may be mentioned here that the fluorescent screen tube forms a most valuable means for rapidly exploring the fielu of the Crookes tube and so determining whether it can be used as a source of Röntgen rays or not. It also enables one to determine the best direction in which the rays are emitted and is much quicker than the sensitive plate for such observations.

In one of the tubes examined the effects appeared to indicate that the Röntgen or anode rays are deflected or turned aside sharply when they arrive near the cathode terminal, which in this case was a bent sheet of aluminum. This effect is worthy of further investigation.

The writer also personally exhausted a Crookes tube by a Sprengel pump, watching with the fluorescent screen tube for the first indications of Röntgen rays. It was found that when that degree of exhaustion was reached which gave an excellent exhibition of radiant matter from the cathode, and even clear-cut shadows of objects by such rays as evidenced by the brilliant fluorescence of the glass where the rays impinged, there still was no indication of Röntgen rays, even when the fluorescent screen in its dark tube was not more than a quarter of an inch from the strongly fluorescing glass wall. As, however, the exhaustion improved, the indications of Röntgen rays began to be manifest, and at last they became quite pronounced. These rays seem to originate at the anode and, although they may possibly be deflected in the vicinity of the cathode, they otherwise proceed in straight lines from the anode and through the glass, causing fluorescence of the latter in much the same way to all appearances as the cathode rays, except that while the cathode ray fluorescence is fairly stable or stationary, the anode ray fluorescence flits about or changes its direction with every discharge, scarcely, if ever, repeating the same pattern of fluorescent patches on the walls of the tube or bulb.

The following summary of effects is apparently in accord with the facts:

1. Cathode rays are produced at lower exhaustions than give rise to anode rays that reach the glass.
2. Anode rays are best produced at the high exhaustions short of insulation.
3. Anode rays pass out through the glass of the Crookes tube; cathode rays (radiant matter) apparently do not.
4. Both anode and cathode rays cause fluorescence of the glass and possibly of many other substances. It is not known whether anode rays cause fluorescence of any substances that are not so affected by cathode rays, and vice versa.
5. Anode rays are erratic in distribution from the anode surface. Cathode rays are of nearly uniform distribution, and leave the cathode surface at right angles.
6. Anode rays are not capable of being deflected by a magnet; at least not after they have passed the glass. Cathode rays appear to be so deflected within the tube and after they have traversed an aluminum window. (Lenard).
7. Diminishing the size of the anode concentrates and focalizes the rays emanating therefrom. Shaping the cathode into a concave cup gives rise to a focus of cathode rays by virtue of their direction being normal to the cathode surface.

The question suggests itself, Can anode rays reach and pass through a thin aluminum sheet which is at the same moment the cathode for the discharge? And, on the other hand, Can cathode rays traverse the anode if of thin aluminum sheet? It is probable that opacity of the opposite terminal would be noted in these cases, and, possibly, deflection of the rays in each case near the terminal of opposite polarity to that emitting the rays.

The significance of Röntgen's discovery is greatly enhanced and the scientific interest therein multiplied when it is recognized that there may be an entirely unsuspected radiation, not from the cathode but from the anode; that both electrodes may emit radiations characteristic of the electric states of the terminals, and that such radiations are widely different from each other and from other known radiations. If the anode rays are longitudinal waves in the ether, what are the cathode rays? If the cathode rays are longitudinal what are those of the anode? Is it possible that neither of them are longitudinal vibrations of the ether and that one must now look for an explanation of the two radiations which shall be alike, and yet not alike?

In these radiations there may be again a manifestation of differences between positive and negative electrical states which differences seem to be in some way impressed on the radiations set up in the neighborhood of the poles. There undoubtedly is a great field for research opened by the discovery of Röntgen, and it is fortunate for science that the Crookes tube he experimented with possessed a high enough vacuum to cause it to give anodic as well as cathodic rays.

THE SPECTRA OF THE BUNSEN BURNER AND EXHAUSTED BULBS.

BY DR. W. H. BIRCHMORE.

THERE are few things more remarkable in the present widespread study of the ether vibrations started in Crookes or other exhausted tubes than the indifference to scientific data which has been shown in the published accounts of results. The unconscionable vagaries of light are well known to all students, but this light, more than any other, counts of results. The unconscionable vagaries of light are displayed by the exhausted bulbs, for no two in my experience give the same hue, caused me to institute comparisons among the spectra. The results of some of these I have compared on paper and they form the basis of this essay. That the volume of data is not larger must be credited partly to the enormous amount of labor involved and partly to a desire to set others, who may be so situated that they can pursue the study, on the track of what I consider an interesting investigation before the interest is exhausted.

To encourage the inquiry among those who have the use of instruments they might fear inadequate to undertake such research, I have pursued my studies, those on which this essay

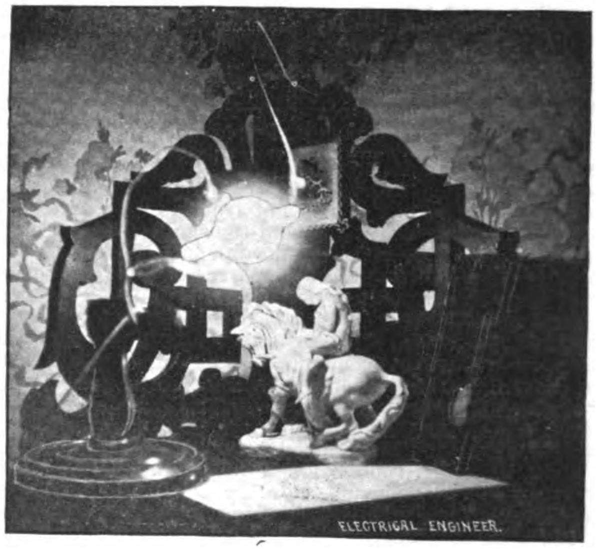


Fig. 1.—CROOKES TUBE PHOTOGRAPH.
(*Copyright, 1896, by W. H. Birchmore.*)

is based, with a comparatively small instrument. The instrument used is the one referred to in my last contribution to hydro-carbon-flame literature[1], and was sufficiently described therein. Any single prism instrument will do for the study and a fortiori any larger one.

Description of the Plate.—To give a ready means of reference the principal Fraunhofer lines on the accompanying plate are shown in No. 1 above the scale. The centesimal scale is the one usually given with small instruments and this is given in line No. 2, while in line No. 3 is the sun spectrum. Great pains have been taken in making choice of the lines shown in this spectrum. My small instrument shows so many that I was in doubt as to the margin between too many and not enough, and I finally concluded to draw in only those found in the ordinary school books, Ganot and the like. In passing it may be well to mention that any one-prism instrument will show about thirty lines when directed against a white wall or cloud on which the sun is shining, and from 400 to 600 when directed against a mirror or the sun itself. An instrument, such as this can be purchased at almost any price between $40 and $100, and one costing about $40 (J. W. Queen & Co.'s

[1] "The Electrical Engineer," March 18, 1896.

"R 55") is quite equal to doing all that any one not specially interested in spectrology can wish to do.

Of the lines shown, D, the sodium line, is the Greenwich meridian for all studies, while E and G are landmarks whose precise significance is still sub judice, but they probably are atmospheric lines. It must always be remembered that lines seemingly single in an instrument of small dispersion often become extensive groups when the dispersion is increased. The D line, for instance, in this instrument shows as a sharply defined line, while with larger instruments it shows as two wide bands and some twenty odd lines.

No. 4, the Bunsen Burner Spectrum.—It is with great sense of the importance of what I am about to do that I approach the discussion of this spectrum. The evidence of its actinic power given by the pictures shown in the last number of this journal is a demonstration of the enormous radiation of "chemical" rays, while the extreme distress of the eyes produced by the same radiation is the subjective evidence of the same fact. This distress is well known to all who in laboratory work have had to watch the working of these flames; for instance, while heating a crucible, the eyes actually seem relieved when the white-hot crucible begins to give off rays which will cause the pupil to close. This is an instance often

covering the flame nearly to the very point, while on the other it extends up less than a third of the way. The Müncke mixes the air infinitely better and gives in every way a better and more rapid and complete combustion. It is but a fair deduction, then, to infer that the gases, both those which burn and those which sustain the combustion, are more nearly at the same temperature throughout than are those of the ordinary Bunsen, and therefore the radiation will have more nearly the same wave length in the waves from the Müncke than from the ordinary burner, and so it is shown by the spectrum to be. In an instrument of sufficient definition and dispersion the band is resolved into a group of infinitely fine lines, showing that there are waves of an infinite variety of lengths, which, combining, form the bands. In other words, the instruments proclaim that in the ordinary Bunsen, the gases are heated so slowly that an appreciable period elapses between the time when they begin to cause undulations, and the instant when they are heated so hot as to combine with the oxygen of the air and to burn.

But the spectrum tells us more; it also says that the gases are heated to a point beyond their temperature of combination, for were this not so the sharp line of each band would be at the end of the shortest waves instead of substantially in the

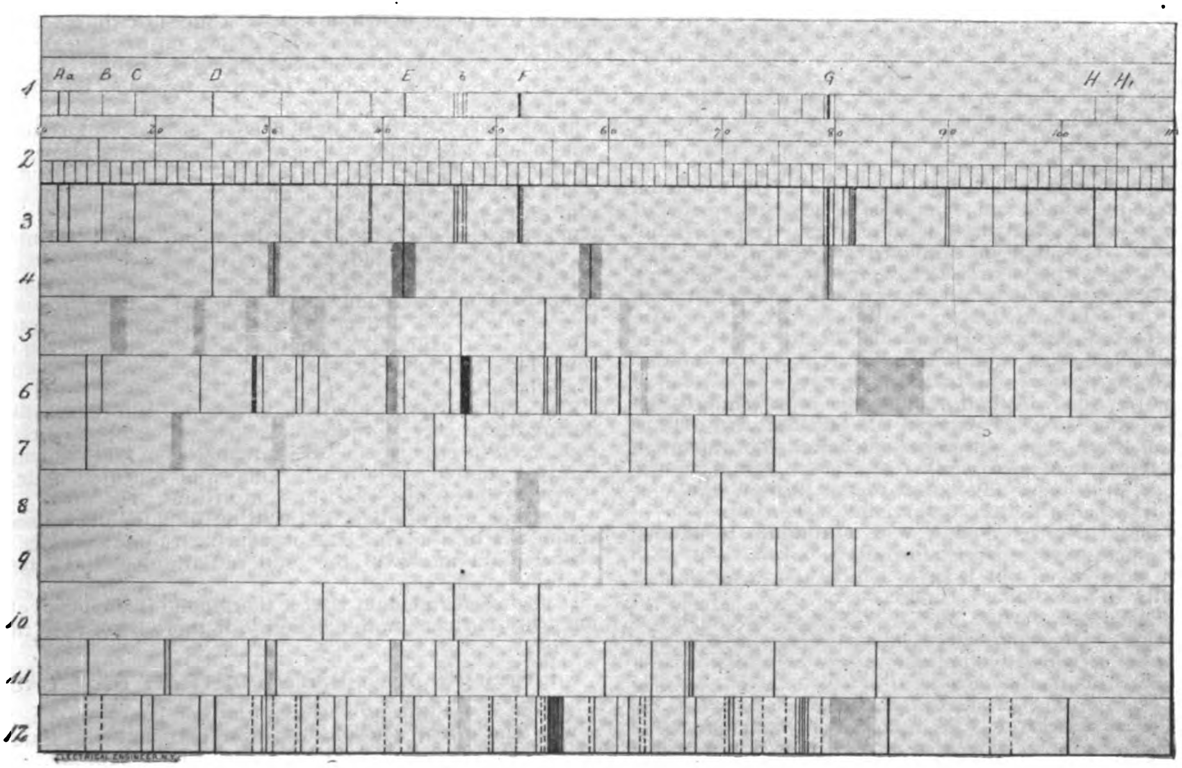


FIG. 2.—LINE SPECTRA OF FLAMES AND VACUUM TUBES.

seen in nature, the pupil closes to the stimulus of light, not actinic or heat rays, and although it will close twenty-five times faster on light rays from the neighborhood of G, than it will for rays from the neighborhood of B, it suffers from the actinic rays while even the G stimulus is too small to affect it.

Two widely different spectra are combined to form the spectrum shown in the plate. One the spectrum from an ordinary Bunsen burner in which the center of the flame is a long green cone, the other the spectrum from the form of Müncke burner, sold by the Welsbach people.

A. The Ordinary Bunsen Burner Spectrum.—This spectrum may be described with sufficient accuracy as being one of four broad bands, and a sodium line.

B. The Müncke-Bunsen Spectrum.—This consists of five sharply defined lines, one the sodium line, two lines in the spectrum answering to 305 and 583; while the other two are substantially identical with E and G of the solar spectrum. This marked difference certainly must strike the attention of every one who sees it, and the more if he happen to superpose the spectra, in which case he finds the bands accurately bisected by the lines, as shown in the drawing. As was mentioned, they differ in no way except the burner used; the difference in the spectrum then must be due to the difference in the physics of the two flames. How, then, do these differ?

If we closely examine the flames we find in one a long green cone, in the other a very short one. One has a violet envelope

middle. Actually, then, the Bunsen burners, as we ordinarily use them, waste no small part of the heat they produce in heating the air and fuel gases beyond any useful limit. This margin of waste, or margin of saving, as we please to call it, explains why the Müncke burner gives a temperature so much higher than that of an ordinary Bunsen. The air and gas are so thoroughly mixed that the green cone of the ordinary burner is only a thin covering to the gauze and heats quickly to the combining temperature, never overheats, and gives a sharp line in the spectrum, and no band.

Line No. 5 is the spectrum of an electric spark passed between two copper terminals, without the introduction of a condenser. No. 6 is the same battery and coil, using another pair of terminals with a condenser in circuit. Where to find the origin of the lines present in No. 5 is indeed a puzzle, for, although they may with sufficient certainty be set down as caused by other metallic elements in the copper, yet so confused a spectrum should not be furnished from a reasonably pure wire by so weak a spark. Here, again, we have the phenomenon of bands, the result of a multitude of waves of about the same length. The three sharply defined lines are one in the green and two in the blue and might be assumed as the blue-green copper lines, but this must be taken with a teaspoonful of salt. In spectrum No. 6 there are many more lines caused by the greater power of the spark, bands are reduced to lines and a new band appears. These changes are interest-

ing, but unsatisfactory; they show how dependent on spark intensity and such small trifles a spectrum may be. For this reason the elements of an experiment should always be given.

The line near D is not D, but a line perhaps corresponding to Kirchof's group of atmospheric lines, which indeed is more than probable in view of the appearance in No. 5.

In No. 6, starting from the left, the first line belongs to potassium; how it came to be in a copper spectrum deponent sayeth not. The next line is one also found in the sun spectrum which Kirchof has not named. The third line, 240 in this spectroscope, is the air group 972-984 in Kirchof's map. The broad band 29 is also an air band, 1,135-1,168, Kirchof. The sharply defined line beside it is the arsenic-antimony group between 1,180 and 1,190 K, a very natural and proper contamination of copper. The next three lines between 320 and 350 are also antimony and arsenic lines. The lines near E are the copper lines of that group, as is also 494; the lines between them belong to magnesium, probably reduced and alloyed from the limestone used in fluxing the copper. A number of additional copper lines follow, until the pair at 580 is reached; these are air lines and play a prominent part in the Bunsen burner spectrum. The group 610-630 are also air lines. This brings us to the group of four lines, 705, 720, 740, 755. Of these 720 is a magnesium line and 755 is a lead line; the other two, like the rest of the spectrum, are not determined in Kirchof's map, and as this is the natural reference list for the larger part of mankind, I have not referred to any other. This spectrum has been given not only for its intrinsic interest, but to emphasize a point which I particularly wish to make, that there are lines recognized and easily recognizable belonging to the components of the atmosphere in which we live and commonly called "air lines."

The Spectra of the Exhausted Bulbs.—No. 7 is the spectrum of a bulb made by Somof and exhausted to less than one-half a millimetre, to what exact limit I cannot say. It is magnificently luminous, of which the annexed engraving, Fig. 2, a photograph taken with its radiation, is proof. The negative pole is a disc of aluminum 20 mm. in diameter, connected with a platinum wire. The anode is a platinum wire. This disc radiates an intense pearl or lavender light by which white can be distinguished from black. Using a weak spark, the distance between the poles is only 22 mm., the spectrum given is the one shown in No. 7. When a condenser is introduced, the spectrum appearing is No. 11; beyond the fact that a few lines are intensified, there is no difference, although the amperage of the current was increased many fold. Here, again, we see the phenomena mentioned in relation to the Bunsen flame, of the non-identity of the actinic and visible spectrum.

No. 8 is a bulb, also, by Somof, with aluminum terminals. No. 9 is one almost exactly like it in design, but of vastly less actinic power than No. 7, but it gives nearly the same colored light, especially if a secondary condenser be used. It should be mentioned that the actinic power of Somof, No. 8, is relatively very low. Of course there was no means at hand by which the degree to which he had exhausted these bulbs could be ascertained, as his method was that of the maker of electric lamps, but a series of experiments has been undertaken by which I expect to ascertain the relations of exhaustion to actinic power by carefully exhausting two lamps of otherwise identical conditions.

No. 10 is a "Buckeye" lamp, with a carbon connected to the positive pole of the coil, and the covering of tinfoil at the top with the negative pole. The lamp acted as a condenser and flashes of lightning ran over it in a most beautiful way. This lamp gave as distinct a fluorescence as any bulb in my possession, while its spectrum is limited to four bright lines, all air.

No. 12 is the spectrum of the arc formed between two aluminum terminals. The lines are those of aluminum and aluminum impurities. The dotted lines show the lines in the copper spectrum which have no corresponding lines in the aluminum one. At the same time the contamination of the aluminum with copper, and copper impurities, as well as with those always found in aluminum, metals of the iron group, and sodium, is distinctly shown. The relations of a number of these lines plainly shows the difference in the temperature of the aluminum and the copper arc, the arc between the copper terminals being very much hotter indeed, as is obviously necessary when the difference in the boiling points of the two metals is considered.

The electrical apparatus used consisted of a zinc-acid-carbon battery, giving a current of ten amperes under five volts pressure; both quantities were measured. This current was sent through a coil having about 0.005 ohm in the primary circuit and 2,000 ohms in the secondary. Under ordinary circumstances this coil gives a 1¾-inch continuous spark. When a condenser is used the spark was reduced in length to ⅜ of an inch; under these circumstances, the spectrum of iron is very finely displayed. This spark has all the sensible features of an arc and is usually so spoken of.

This e. m. f. is far more than is needed to run the bulbs. In fact, with many bulbs, I find a current of ten amperes at 1½ volts is all that is needed to excite the coil, but, of course, this is utterly insufficient in obtaining the spectra of metals.

MERCURY, LAMPBLACK, THERMOPILE AND X-RAYS.

BY I. THORNTON OSMOND.

Mercury, lampblack, and the thermopile are intimately connected with the measurement of radiant energy. All attempts to measure the solar constant have assumed that the energy of solar radiation is either in the form of heat or in some form totally convertible into heat by the apparatus used. For several years (see "The Electrical Engineer," November, 1892, p. 443) I have believed that this assumption needs better evidence before results in any wise dependent on it can be accepted as certainly correct.

On March 10, 1896, I exposed to the X-rays from a Crookes tube actuated by a large inductorium, a paper box filled with pressed lampblack powder about 3 mm. in thickness, a paper box lid (empty), a paper box containing about 3 mm. depth of mercury, a piece of windowglass, a piece of thick sheet aluminum, and a silver quarter of a dollar, on the outside of an ordinary camera plateholder, containing a Carbutt dry plate. All colored paper was carefully removed from the top and bottom of the paper boxes and lids.

The mercury (as in an earlier trial) proved very opaque. The lampblack was highly transparent, apparently absorbing none of the X-rays. On March 16, I placed a paper box filled to a depth of 3 or 4 mm. with lampblack on the face of a thermopile of 49 pairs of bismuth and antimony, and over the lampblack the Crookes tube. The thermopile could be quickly put in circuit, without moving it or the lampblack box, with a highly sensitive mirror galvanometer at some distance. The hand held for a second or two before, but not touching, the thermopile gave a deflection of 25 or 30 mm. The lampblack cut off any heat radiated from the warmed part of the Crookes tube, but transmitted the X-rays, as shown in the experiment of March 10.

The coil was put in action, taking 1,500 to 2,000 discharges during about three minutes. Then the thermopile was quickly connected in circuit with the galvanometer. There was no certainly readable deflection. This was repeated four or five times, at intervals, with the same result.

It seems evident that the coating of lampblack used on instruments in studying and measuring radiant energy will not absorb (and measure) the total radiation, if there be X-rays therein.

It also seems evident that a thermopile (bolometer, etc.) will not truly measure radiant energy, if there be X-rays therein.

LINES ON AN X-RAYS PORTRAIT OF A LADY.

She is so tall, so slender; and her bones—
Those frail phosphates, those carbonates of lime—
Are well produced by cathode rays sublime,
By oscillations, amperes, and by ohms.
Her dorsal vertebrae are not concealed
By epidermis, but are well revealed.

Around her ribs, those beauteous twenty-four,
Her flesh a halo makes, misty in line,
Her noseless, eyeless face looks into mine,
And I but whisper, "Sweetheart, Je t'adore."
Her white and gleaming teeth at me do laugh.
Ah! lovely, cruel, sweet cathodograph!

LAWRENCE K. RUSSELL in "Life."

ROENTGEN RAY EXPERIMENTS.

Mr. Edison is steadily continuing his experiments on Röntgen rays at his laboratory at Orange, N. J., and last week succeeded in making visible metallic objects and the bones of the hand through a block of wood 8 inches thick. These results were accomplished by the use of a phosphorescent screen of tungstate of calcium, placed between the eye and the Röntgen tube. Professor O. N. Rood, of Columbia University, New York, has succeeded in demonstrating by the aid of photography, that a small percentage of the Röntgen rays falling on a platinum mirror at an angle of 45 degrees, is reflected. The bacteriologists of the New York Health Department have been experimenting to determine what effect the Röntgen rays have on the bacilli of tuberculosis and diphtheria. Thus far their results have been negative, the cultures apparently thriving unaffected under the influence.

SHADOW PICTURES BY ARC LIGHT RAYS.

BY W. W. KER.

WHEN a new discovery is announced men immediately set to work to make themselves familiar with its details and make improvements in the process, or endeavor to deter-

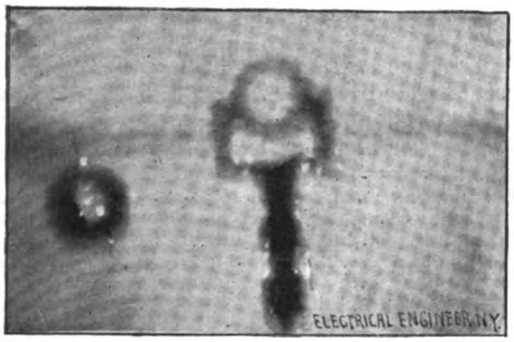


FIG. 1.

mine if the same result can be accomplished by simpler means, and thus add valuable data for the formulation of a theory or to strengthen that which may already exist. So I may be par-

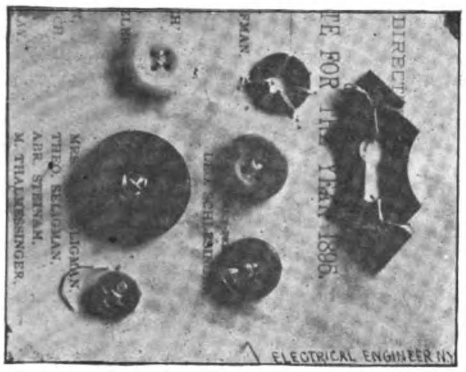


FIG. 2.—PORCELAIN BUTTON. LARGE PEARL BUTTON. SMALL PEARL BUTTON. HARD RUBBER WASHER. BONE BUTTON. IRON BUTTON. BRASS ESCUTCHEON.

doned for encroaching on your valuable space with something of little practical value, but which may add a few facts concerning the production of X-rays by an arc lamp.

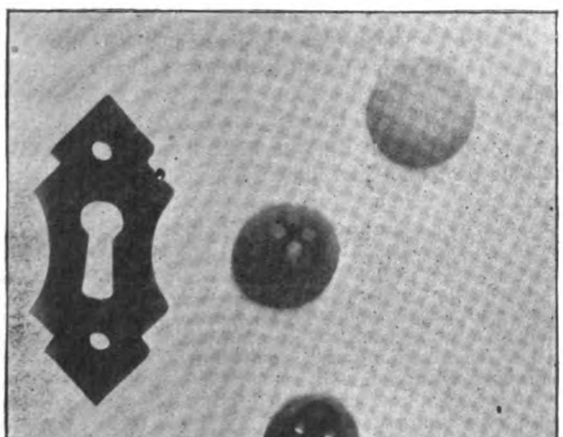


FIG. 3.

The method employed in making the following experiments was to sew the objects to be exposed on a piece of stiff paper and place them on the film side of a slow Seeds dry plate, commonly used for making lantern slides. The negatives and objects were then placed in the plateholder and the pasteboard slide put in position, covering all. The plateholder was then placed about eight inches from the arc lamp, care being taken to prevent the film from melting, due to the heat radiated by the arc. After exposure the plates were developed in the usual manner.

The following plates were made during the week beginning

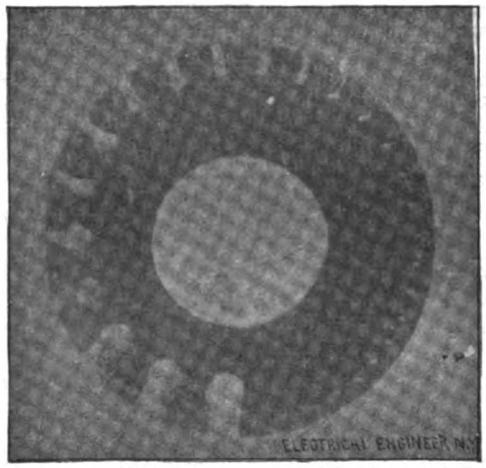


FIG. 4.

Feb. 23, in the electrical laboratory of the Hebrew Technical Institute by the writer, assisted by Mr. S. Hamburger, of the class of '96.

The first plate exposed to the arc was covered with a piece of paper having a brass key tag and a package of sewing needles fastened to it, as described above. The result, after 45 minutes' exposure, showed that the key tag and the paper of needles had shut off the rays, leaving the shadow of the objects very clear and the glass transparent, while the rest of the negative was very black. On examining the plate I concluded that it could not be due to Röntgen rays, because the steel needles did not appear and the black paper had not been penetrated.

The second plate, Fig. 1, represents an iron key and a copper

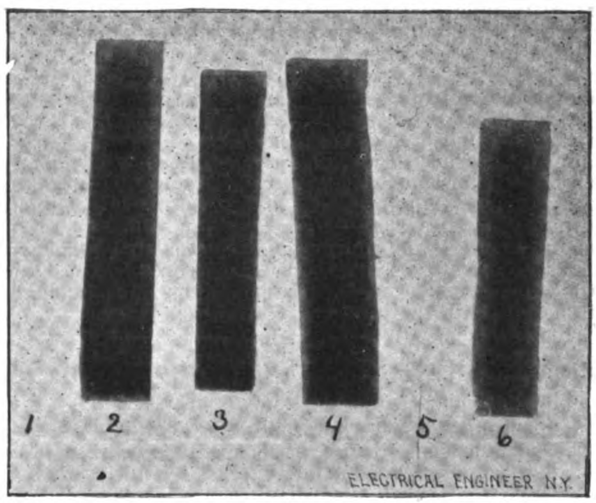


FIG. 5.—CELLULOID STRIPS: NO. 1, YELLOW; NO. 2, DARK BLUE; NO. 3, PINK; NO. 4, BRIGHT BLUE; NO. 5, RED; NO. 6, TRANSPARENT.

washer fastened to a piece of paper, put in the plateholder and exposed to the sun 4½ hours. An examination will show how the paper helped to weaken the rays; the light readily passed through holes made in the paper while sewing on the articles. One notable fact indicated by the time of exposure is that the arc had greater penetrating power than the sun, and it might possess Röntgen or other active rays which the sun did not.

For experiment, No. 3, a number of buttons made of differ-

ent materials, and shown in Fig. 2—which is an ordinary photograph made with a camera by daylight—was placed on a negative and exposed to the arc for 30 minutes and developed in about 20 minutes. It will be seen (Fig. 3) that the brass escutcheon and the metal and bone buttons have stopped the rays completely, the porcelain partially, and the hard rubber washer 1-16 of an inch thick; but the two pearl buttons had no effect whatever in shutting out the active rays.

In my estimation this negative is the result of X-rays or another action and not of ordinary light, as stated by Professor Stine and Mr. W. H. Freedman, in the issue of "The Electrical Engineer" of March 11. If the result had been due to ordinary light, it is fair to assume there would have been some trace of these bodies on the print.

The fourth experiment consisted in making a negative of an ordinary steel wire gauge fastened to a piece of paper, put in the plateholder and placed in a ½-inch pine box. The result

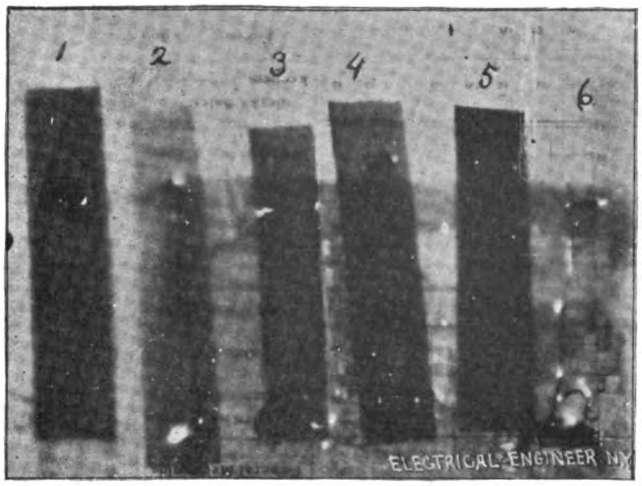


FIG. 6.

of 55 minutes' exposure is shown in Fig. 4. In this case it was necessary for the rays to pass through a ½-inch pine board, the pasteboard slide, and the paper holding the object.

I think the above facts are sufficient to prove that there are X or other rays emanating from the electric arc light.

In order to examine the effect of color by the rays, I fastened a number of colored strips of celluloid to a piece of paper in the usual manner and placed them in the plateholder, which was exposed for 30 minutes, and the result is shown in Fig. 5. The active rays were cut off by the transparent, the two blue and the pink strip; the yellow and red strips, such as are used by photographers to shut out the actinic rays when developing negatives, had allowed the rays to pass without the slightest obstruction, and to act on the plate.

While endeavoring to reproduce the above result under apparently the same conditions, opposite results were obtained, as shown in Fig. 6, and for the first time in my experiments the printing on the paper appeared.

This most interesting phenomenon will be further investigated at the laboratory of Dr. W. J. Morton, who has kindly offered the writer the use of his apparatus for making comparative tests with the vacuum tubes and arc lamp.

EXPERIMENTS WITH INCANDESCENT LAMP AND MAGNETS.

AT a meeting of the Physical Society, held on Feb. 28, Sir D. Salomons showed some experiments with incandescent lamps. A large electromagnet is excited by means of a continuous current, while an alternating current is passed through an incandescent lamp. On bringing the lamp near the magnet the filament is set in vibration, which, if the lamp is brought sufficiently near the magnet, is sufficiently intense to break the filament. The number and position of the nodes formed in the vibrating filament are found to be independent of the natural period of the filament, but depend on the frequency of the alternating current.

STEAM EXPLOSION IN A NEW YORK STATION.

By the explosion of a steam chest in the engine room of the East River Electric Light Company, No. 425 East Twenty-fourth street, this city, last week, Edward Whipple, an oiler, was killed, another oiler was slightly injured, and damage amounting to about $5,000 was caused.

RELATIVE EFFECTS UPON EACH OTHER OF THE ELECTRIC SPARK AND THE FLUORESCENT SCREEN.

BY EDWARD P. THOMPSON.

RECENTLY various writers have discussed the question, What is electricity? Each new fact may assist in arriving more closely at a determination of this question. The following experiments may favor those who hold to the two fluid theory:

I produced a spark between the poles of a Wimshurst machine. The spark, as it appears, may be compared to a ray of violet light entering a dark room, or it may be compared to a fine stream of violet liquid. If a violet ray of light is passed through a fluorescent screen it is of a different color after its transit. The same with respect to white light. For example, I passed a violet ray of light through a screen of barium platino cyanide. As is well known, the light is violet on one side before entering, and green on the other side. I performed a similar experiment with the electric spark.

If the electric current consists of a single fluid having a violet color or white tinted with violet, and passing from one pole to another, then, if it is intercepted by a fluorescent screen, it should appear violet before passing through the screen, and green after passing through it. The experiment showed, however, that the spark was green only while passing through the screen, which was about ⅛ of an inch thick, and made of a translucent mixture of varnish and barium platino cyanide, finely pulverized. If the current consists of two fluids, one coming from one pole, and the other from the other pole, and both passing through the screen, we would expect the experiment to exhibit some violet light in the spark on both sides of the screen, while within the material of the screen, both fluids would appear green. Such was the result of the experiment.

I submit the experiment not for the purpose of proving anything absolutely one way or the other, but to publish the fact established by the experiment as food for thought.

Independently of this experiment, I also produced a brush discharge from one pole. I arranged conductors in such a way that the projected sparks or rays from the pole struck upon the surface of a fluorescent screen, located at the end of an opaque tube, which was provided with metal points behind the screen to act as the other pole. The screen became uniformly luminous by the action of the brush discharge passing through it, first puncturing two thicknesses of black paper. No fluorescence was obtained outside of the path of the brush discharge.

It was necessary for the sparks to pass through the black paper before any fluorescence was obtained. A piece of wood cast as much shadow as a piece of iron. If too thick and not wide, the sparks went around the objects. Other experiments were tried, and they, as well as the above, proved apparently that there are no X-rays radiated from, nor in the direction of, the electric spark, produced by a machine of the capacity of the one I employed—4-inch spark.

March 14, 1896.

AN ELECTRIC THEATRE FOR BOSTON.

A theatrical project is on foot in Boston for an electrical theatre, which will be duplicated in London. The originator of the idea is Mr. Oscar W. Rogers, of Chicago. In 1895 he had a long conference with Wilson Barrett and interested him deeply in his projects. Mr. Rogers also interested the late Eugene Field in the scheme.

The peculiarity of the theatres lies in the way in which they are operated. Mr. Rogers has a series of inventions applicable to stage uses. He proposes to operate nearly everything behind the curtain by electricity. The drops, borders, curtains, both green and act, the side scenes, and, in fact, every mechanism which is now operated by the pulling and hauling of stage hands, will be moved by the electrician at the prompt wing. This will be accomplished by a series of small but powerful electric motors, each working on an independent circuit, and all within easy control of the electrician. Then Mr. Rogers proposes to accomplish scenic effects with electricity. Sunset and dawn, the glare of noonday, lightning and tempest, rain effects, moonlight, and, indeed, every possible atmospheric condition. Illumination, both in front and back of the curtain, will be accomplished in an entirely new and novel manner, and some beautiful effects secured. There will also be electric doors, entrances and exits. On the stage the hands will be limited to the property men and a few assistants, necessary to arrange the "props." It is to be hoped he will think it worth while to provide also a few good plays.

MAY NOT THE X-RAYS PROCEED FROM FLUORESCENCE ONLY ?*

BY WILLIAM JAMES MORTON, M. D.

THE source and nature of the Röntgen ray claim continued interest. An experiment I have made and may here record would seem to demonstrate that the Röntgen ray is a property, neither of the cathode nor (as pointed out by Professor Rowland and Professor Elihu Thomson) of the anode, but rather that it proceeds solely and alone from a substance fluorescently excited within a vacuum tube. In this case, either anodic or cathodic streams projected upon a fluorescent substance, such as the glass of the bulb or other substance supported independently within the bulb, acts merely as a special excitant to the fluorescent. Electricity becomes of secondary importance; it is merely a convenient method of setting up a condition which is of importance, namely, fluorescence.

The accompanying sketch, Fig. 1, and reproduction of a shadowgraph, Fig. 2, are offered in support of these remarks:

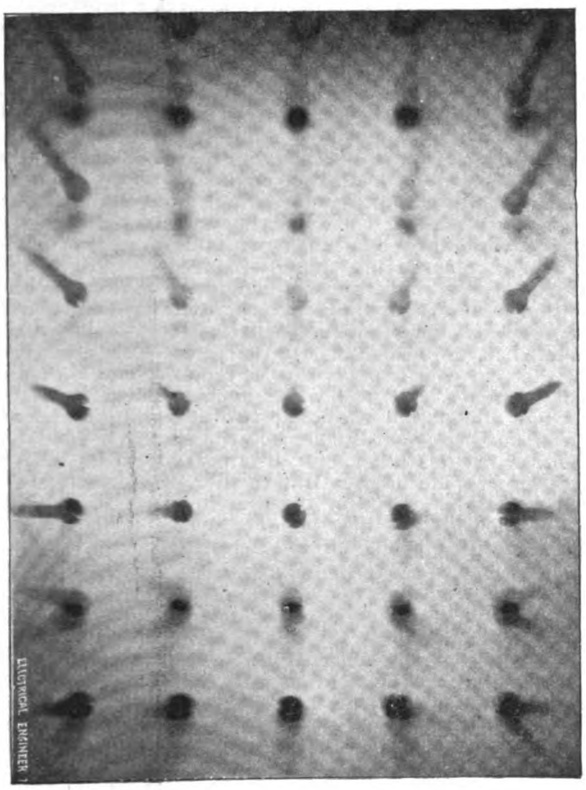


FIG. 2.–PHOTOGRAPH SHOWING LOCATION OF ROENTGEN RAY ORIGIN.

Fig. 1 is a vacuum tube containing a piece of fluorescent substance mounted upon an independent support; c, cathode; a, anode; f, cube of fluorescent material; p, plateholder, containing sensitized plate; r r, radial streaming lines, indicating the source and direction of radiation as shown by the shadows cast of ¼-inch screws placed upon the slide of the plateholder.

The Crookes tube, containing the independently-mounted piece of fluorescent substance is amply defined in the sketch. Upon the plateholder were placed, at the intersections of lines an inch apart crossing each other at right angles, forty ¼-inch screws, resting upon the flat part of their heads. The tube was suspended about two inches above the plateholder and having its longitudinal axis directly above the middle and longest line of screws. The edge of the fluorescing cube was just above the third screw of the middle line mentioned. The plate exposed was 6½ by 8½ inches in dimension and about the length of the tube.

By inspection of the print, Fig. 2, it will be observed that the main effect of the radiation recorded upon the plate was anterior to the cube. The screw beneath the cube has no shadow and may be supposed to represent about the central point from which the radiation emanated. The shadows cast bear out this supposition. There are to be seen other but minor shadows. These were due to a moderate general fluorescence of the tube, to some green streamers which shot out from behind the cathode and to the fluorescence of the glass behind the cube where cathodic rays, which failed to hit it, had passed onward.

The time of exposure was 30 minutes; the excitation (by a static machine) moderate; the action of radiation from the cube was, of course, impeded by passing through the glass at a disadvantageous angle.

I am now using a tube designed to embody this idea of utilizing the radiation of fluorescent material mounted within the bulb and independent of it. The cathodic rays are focused

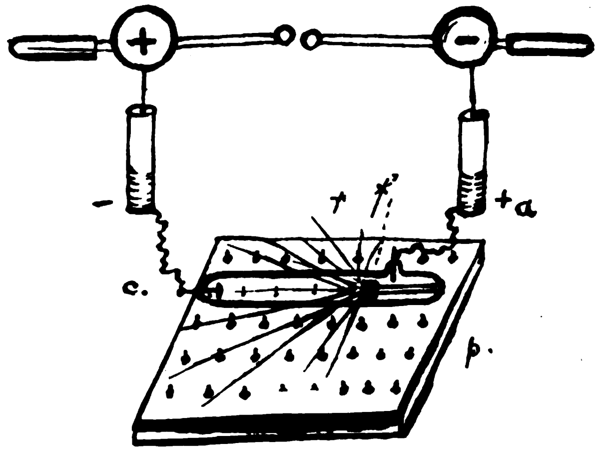


FIG. 1.

upon the fluorescent material, which, in turn, is arranged so as to be the active agency in affecting the sensitized plate.

This experiment tends to show that the X-ray may be due to fluorescence alone. It points to the view that we have merely to deal with a rate of vibration far below that of the familiar infra red rays, but nevertheless, with transversal waves and thus with a phonomenon of the nature of light.

Incidentally, it may be noted from inspection of the print that the shadows cast are opposite to what they would have been had the source of radiation been at the cathode and that they do not correspond with radiation from the anode.

THE DANGERS OF ALTERNATING INCANDESCENTS.

The death of W. S. Goff at Winchester, as a victim of an electrical shock from an ordinary incandescent lamp, brings again before the public the necessity of some legislation whereby the criminal negligence in allowing such conditions to exist should be dealt with severely.

This fatal case is by no means the first, nor will it be the last, of similar deaths from this very same condition, which is well known to electrical men.

It is a case of dollars against lives, and any person who is a user of electric lights supplied from the alternating transformer system, as is commonly done in the suburban districts, places his life in the hands of the electric lighting company.

If the scientific part of the business is looked after by a thorough and competent man not bound down by a niggardly management, the electric lighting in buildings is as harmless to life as a wax candle. But in very many cases, there being no legislation to prevent, an incompetent man looks after the business, caring little for anything but to make the lights burn, draw his salary and trust to luck regarding any one receiving a death-dealing shock.

If a law were passed forcing every electrical company doing commercial and domestic lighting on the alternating transformer system to either regularly test its transformers for leaks between primary and secondary windings and for grounds, or to ground the secondary winding at the transformer, it would eliminate one of the most dangerous conditions known in the electrical business.

I am aware of the objections which may be raised against grounding the secondary winding from transformer, but they are mostly due to the added expense in the construction work.

However, if this were done there would be no more loss of valuable lives through the medium of the innocent-looking incandescent lamp.

If this morning Herald's interview be correct, as it probably is, the superintendent's statement that "there was no indication that any increased voltage was escaping, for the lights did not act in any other than the ordinary manner," it proves nothing but that he is grossly ignorant of the conditions required to cause death, or that he has got a most peculiar kind of electrical construction work existing.—(Boston Herald.)

POWER TRANSMISSION.

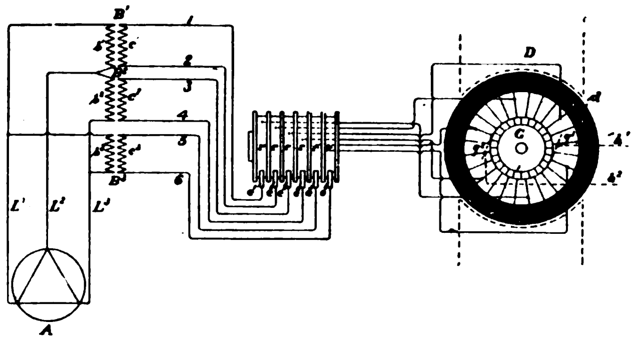
MERSHON'S MULTIPHASE DISTRIBUTION SYSTEM.

IN the transmission of multiphase alternating currents it is customary to employ as few conductors as possible for conveying the currents and to connect these conductors to an equal number of points in the winding of the rotary converter.

Mr. R. D. Mershon, of the Westinghouse Company, has found that by transforming the alternating current thus transmitted into a larger number of phases and correspondingly increasing the number of leads to the rotary current transformer winding the loss in the rotary transformer is decreased; or, in other words, the capacity of a given transformer is increased. For example, if a three-phase current is transmitted over three conductors it may be transformed by means of three converters, the secondary terminals of which, instead of being interconnected, are independently connected with six electrically-equidistant points of the winding of the rotary transformer. The output of the rotary transformer system, so arranged, will be approximately 40 or 45 per cent. greater than if the three main-line conductors were directly connected with three points in the rotary transformer.

The accompanying drawing illustrates in diagram an arrangement of apparatus embodying the above principles.

Referring to the figure, A represents a source of three-phase alternating electric currents, and L' L^2 L^3 three main-line conductors leading therefrom. At the point where it is desired to



THE MERSHON SYSTEM OF MULTIPHASE DISTRIBUTION.

transform the multiphase currents into continuous currents there are placed three transformers B' B^2 B^3 the primaries b' b^2 b^3 of which are connected with the main lines L' L^2 L^3 in the usual manner. The secondary coils c' c^2 c^3 of the transformers are connected with conductors 1, 2, 3, 4, 5, and 6, and these conductors are connected with contact brushes e' e^2 e^3 e^4 e^5 e^6, and through these contact brushes to the single closed armature-winding d of a rotary transformer D. The six contact rings, r, corresponding to the respective contact brushes e' e^2 e^3 e^4 e^5 e^6, are connected with equidistant points in the winding of the rotary transformer. The commutator G of the rotary transformer is supplied with brushes g' g^2, through which continuous currents are delivered to the conductors h' h^2, and the continuous current thus derived may be employed for any desired purpose.

According to Mr. Mershon, the increase of output is due to the fact that at the instant any one of the alternating-current leads coincides with one of the direct-current brushes the current borne by this alternating-current lead is feeding directly into the direct current brush without passing through the armature-winding of the rotary transformer. Consequently the greater the number of alternating-current circuits feeding the armature of the rotary transformer the greater will be the amount of this direct feeding and the less will be the loss in the armature of the rotary transformer due to its being traversed by the alternating currents.

A BROOKLYN POWER WAREHOUSE.

The Brooklyn Wharf Warehouse Company, whose extensive plant extends from Catherine street ferry to Gowanus Bay, has in contemplation the establishment of an electric railroad to facilitate the handling of its merchandise, the abolishment of the present dummy hoisting engines and the lighting by electricity of all their warehouses and elevators. The present plan for the electric road includes a line only from Fulton street to Atlantic avenue.

ELECTRIC TRANSPORTATION.

CAN ELECTRICITY SUPPLANT THE STEAM LOCOMOTIVE ON TRUNK RAILWAYS ?—V.

BY

Wm Baxter Jr

UP to this point the various directions in which the operating expenses can be reduced are those that relate to a reduction of the coal bill. This item, as has been shown, amounts to about 10 per cent. of all the other expenses, and the portion of it that can be saved by reason of the reduced cost of delivering energy on the track by the electric system amounts to about 55 per cent. But this saving, as has been shown, may be increased in some cases, owing to the fact that the coal consumption of a locomotive is largely dependent upon the skill with which it is handled, while such a condition does not in any way affect the efficiency of an electric motor. It has also been shown that a further reduction can be made, owing to the fact that the weight of electric motors required to haul a given load would be much less than that of steam locomotives of equal capacity, and finally it has been shown that a very decided saving can be made in that portion of the work that is performed by switching engines.

The saving in relation to the coal bill, then, stands about as follows: Total saving equals saving due to reduced cost of energy delivered on track, plus saving due to skill of engineer and fireman, plus saving due to reduced weight of motive power required to haul the train, plus the saving effected in doing the work of switching engines. It is evident, therefore, that 55 per cent. does not represent the total saving that can be effected in the coal bill. Of the three other directions in which the coal consumption can be reduced, one is of an uncertain character, and its bearing upon the final result is not easily determined; but the other two are positive sources of gain and must necessarily increase the saving beyond the 55 per cent. mark; to what extent, it is possible to estimate with a fair degree of accuracy. But further consideration of this subject will be deferred for the present, as it is desirable to point out the various other items of operating expenses that can be reduced by the adoption of electricity.

Reduction of Labor Account.—The work that has to be performed upon a locomotive while in motion is such that the services of two men are required, one to control the movements of the engine, obey the signals along the track, etc., and the other to attend the boiler. With an electric motor, as there is no boiler or its equivalent to take care of, the services of the fireman become unnecessary. It is claimed that, although this is true, nevertheless an extra man would be required to take the place of the motorman should he become disabled through any cause. This is undoubtedly true, for it is easily conceivable that the motorman might, without warning, be seized by a fit or a fainting spell, or drop dead from heart failure, and in such an event if there were no one to take his place the results might be very serious. It is further claimed that in passenger service the presence of a second man is required so that the risk of misinterpreting the signals along the track may be reduced to a minimum, the explanation of this being that the fireman tells the engineer what his interpretation of the signals is, and if the engineer is of the same opinion the train goes ahead, otherwise it is stopped, and the real situation ascertained.

A train drawn by electric motors would require the presence of a second man, while in motion, at the side of the motorman, but, as will be shown further on, this man could have other duties to perform, and his wages could in no way be charged up against the cost of operating the motors. The use of two men so as to avoid misunderstanding signals would hold good on an electrically operated road if the present block signal system were used, but it is perfectly feasible to control the movements of trains on a road operated by electricity, by an automatic system, in which the judgment or watchfulness of the motorman would not have to be depended upon. In such a system every train would be under the control of the train ahead of it, and would be automatically stopped as soon as the distance between the two became less than that to which the system was adjusted.

The motion of trains would also be governed by the position of switches along the track, or by a train coming in the opposite direction. Such a system would be far more reliable than that now in use, which depends not only upon the watchful-

ness and intelligence of the engineer and fireman, but also upon the reliability of the operator who controls the signals. That the present system is not absolutely safe, is well demonstrated by the many accidents on record that are chargeable to it. It would, therefore, be folly to use the present system when a new one could be adopted that would not only be safer, but more economical, not only because it would reduce the cost of operating a train, by so simplifying the work of the motorman as to make it unnecessary to employ two men specially for this work, but also because a large portion of the wages of men required to operate the present system would be saved.

It is claimed by many who profess to be experts in railroading, that the reason why locomotives do not make greater mileage is not so much because they will not stand the strain, as it is, that the duties of the engineer and fireman are so great and their nerves are so taxed by the constant watching of signals, that they could not endure the strain for any greater distance. If this is really so, then the automatic block system that could be used on an electric road would enable a motorman to cover a much greater distance per day than the present run of a locomotive, because the greater part of the work of watching for signals would be done away with.

As to the ability of motors to withstand the strain, we know that they can run eighteen hours per day without any undue wear, as thousands of them are doing that much work every day at the present time, and in the most trying kind of railroad service.

It is evident that if the above assumptions are correct, the system of automatically controlling trains, as suggested in the foregoing, would make a great reduction in the labor account, as the daily runs would be of longer duration and therefore cover more miles; hence the labor account per train mile would be greatly reduced.

There is one item in the expenses of operating steam roads that would be entirely eliminated by the adoption of electricity, and that is, the cost of supplying fuel and water along the line for the locomotives. In a great many places water has to be pumped into the tanks from which the tenders are replenished; coal also has to be elevated into pockets, considerably higher than the top of the locomotive tenders. These coal and water stations require attendance, and the amount spent per year in this direction runs up into large figures. The latest railroad reports do not give the operating expenses sufficiently in detail to enable one to determine what percentage this item forms of the whole, but an old report of the New York Central Railroad gives the amount expended for this purpose as equal to about 10 per cent. of the wages of engineers and firemen combined, or, in actual figures, $110,430. The total expenses of operating the road for that year footed up about $18,000,000, so that the cost of coal and water station attendance constituted about six-tenths of 1 per cent. of the whole cost of operating the road.

THE NEW NIAGARA TROLLEY BRIDGE.

The bridge soon to be built across the Niagara gorge by the Niagara Falls and Clifton Suspension Bridge Company, will be a remarkable one in several ways. It will have a span, between centers of end pins, of 840 feet, and will be much the longest arch span in the world, the present longest span being the 566 feet of a bridge at Oporto, Portugal. The arch will be built out from either end, without false works, which would be quite impossible in the Niagara gorge. The bridge will carry one floor forty-six feet wide, divided longitudinally into three parts. On the middle portion will run two trolley-car tracks; this is twenty-two feet nine inches wide. Each side of these tracks will be an eight-foot roadway for carriages, and outside of these will be raised sidewalks three feet nine inches wide. The suspension bridge now used for highway and footpath will be kept in service until the new arch is ready for use. The center lines of the two bridges do not coincide, being on the New York end about thirteen feet nine inches apart and meeting on the Canadian side.

ADVERTISING IN TROLLEY CARS.

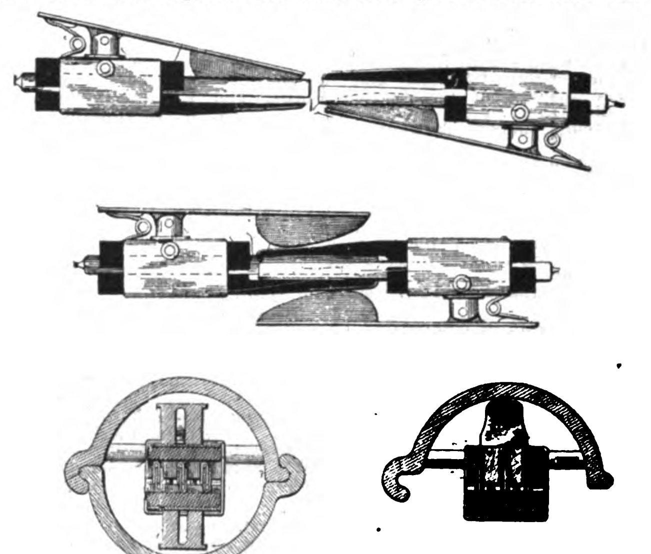
A street railroad company in Pennsylvania, which sought to recover on a contract for advertising in its cars, failed in court for the reason that advertising was not its legitimate business. The courts are again asked to pass on this interesting question. A stockholder in a Pittsburg street railroad corporation is suing for an injunction to restrain the corporation from engaging in the advertising business. The corporation, the petitioner says, was created for the sole purpose of constructing and operating a street railroad, and for the conveyance of passengers and produce only on its railway. It has no right or power to engage in any other business, and its wrongful entry into the advertising business puts in peril the charter and franchise of the corporation and the interests of the stockholders.

DEVINE'S AUTOMATIC ELECTRIC TRAIN SIGNAL.

When Mr. Westinghouse applied his air whistle to railway trains, there were railroaders who believed that the millennium had been reached as far as signaling was concerned. A clever contrivance is this air signal, but it is still restricted to passenger trains, and may be for many years to come. The other half of the railway world—freight service—is still left to the tender mercies of the "bell cord."

One does not need to have more than a superficial knowledge of railroading to know that the present system of signalling on freight trains is very defective. There are no means of rapid communication between front and rear trainmen. The bell cord is a useless ornament; in nine cases out of ten it is not in working order when required and owing to this lack of means of rapidly calling for brakes, loss of life and property frequently result. It is with a view of filling this serious want that the Devine electric train signal was invented. This signal system consists of three small insulated wires running from end to end of the train through a weather-proof cable. At each end of the cable is a coupling, as shown in Fig. 1, which is coupled onto a similar one at the locomotive and caboose.

When the couplings are closed, as shown in Fig. 2, there is direct and instantaneous communication between engineer and rear trainmen by means of push buttons and bells in locomotive and caboose. Two open circuit batteries are used at each end. A code of signals has been arranged to establish communication between front and rear trainmen on moving freight trains.



FIGS. 1, 2 AND 3.—DEVINE'S AUTOMATIC ELECTRIC TRAIN SIGNAL.

By means of this code rapid communication is effected. But provision for rapid communication between engineer and conductor is the least of the merits of the invention. Another, that will be appreciated by railway companies is, that danger of collision between sections of broken freight trains, may be avoided by the use of the new signal. Up to the present, the breaking of a simple coupling link has always been attended with great danger, all the greater if the break occurs on a grade or on roads where the block system is not in vogue. The Devine signal gives alarm at both ends as soon as a train parts and this it does automatically. Interlocking metallic plates, B B, inserted in the coupling tubes, as shown in Figs. 1 and 2, cause the wires to short circuit automatically at the point of separation. The bells start ringing immediately in the caboose and engine cab, warning the trainmen to reverse the lever and apply the brakes.

The device is very simple and cheap. Messrs. Otto & Noad, of this city, are making arrangements with some of the leading roads to have practical tests made.

FORBIDDING TROLLEY FREIGHT IN NEW JERSEY.

In the New Jersey Legislature on March 11, the House, after a long discussion, and by a vote of 43 to 8, passed the Skinner bill prohibiting trolley companies from carrying freight.

THE

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CONTENTS.

THINGS THAT ARE FREE.

At such a time as the present, when two of the largest electrical manufacturing companies in the field of electric light and power have decided to work together instead of against each other, it is of interest to inquire how much of the art or industry they can control by the combination of their patents. It might seem that this patent pooling would operate seriously as a bar to general freedom of trade, but we are free to confess that few real features in the nature of patent monopoly arrest our attention, although a great deal is said about them in the recent proclamation. The wonder is, not that so much has been tied up, but that so much is left free and is absolutely uncontrollable, except, of course, by a policy of low prices.

As a matter of fact, the manufacture of all direct current dynamos and motors is to-day broadly free. There are, no doubt, many excellent detail and specific patents worth having, but they are in various hands, and are often conflicting by their very nature. In other words, any man to-day who is a competent designer and builder, can turn out a direct current dynamo or motor of the best form and the highest efficiency, and pay tribute to nobody. This is true of practically all sizes.

Not less is it true of alternating current apparatus of the generating class. We know of nothing that can restrain any one from manufacturing good alternating generators. Such machines are really the oldest known to the art, and, while here again, definite types are patented, the main idea has long been public property. Even the two-phase generator is broadly free. There are very broad patents on two-phase motors and schemes of distribution; but, even here there has been no adjudication in the patents; and the whole attitude of the courts is unfavorable to the sweeping interpretations that were in vogue ten or fifteen years ago.

Next come the lamps. Anybody to-day can build a good arc lamp and a good incandescent lamp in absolute security. There are many excellent patented types on the market, in both classes, but their mutually conflicting merits are not only a justification of their existence, but a guarantee of that competition which is the best condition of things for any art.

The field of work next in line is that of the electric railway. So far as we can see there is here nothing controlling, except the under-running trolley patent, in its limited and restricted form, with the auxiliary switches. It would be remarkable if no other method should be found feasible but that. As to the underground trolley, there must be a dozen practical systems now available. Besides, even if the underrunning trolley be more of a "club" than is believed, the temper of the great street railway corporations is not such that they would readily tolerate its application to themselves when they are in the market for generators, motors or general supplies.

The three-wire system of distribution also has, we take it, a patent life of two or three years here; but it is a fact that the Hopkinson patent has expired in England and is now seeking revival. But if that were used offensively, is it likely that the results would be any happier than they were in the lamp fighting?

And this brings up, incidentally, the position of the licensee local companies, particularly the Edison. This new "deal" must certainly exclude the Westinghouse Company from all of their territories, which are some of the richest in the country, and should, one would think, render helpless and hopeless the Westinghouse stations that now exist in Edison districts. If not, then some compensation must be paid the Edison companies as a matter of equity.

We have not alluded yet to large groups of apparatus and appliances needed in modern light and power work, such as storage batteries, electric heaters, switches, sockets, instruments, etc. In some of these cases there has been extensive and justifiable consolidation, but we should be sorry to affirm that in any instance final and absolute control has been established or can be. Turning to wires and cables, these are all free, subject only to specific patents of limited scope, and the same remark would appear to be true of methods of conduiting and the multitude of devices employed. Then come such varied specialties as converters, electric elevators and carbons. Nobody will be bold enough to assert that these can be monopolized on a patent basis.

If asked to say briefly wherein the combination recently effected and likely, perhaps, to be carried further in a complete union of the two companies amounts to anything, we should be driven to the conclusion that it must rest, not on any patent control, but on a supremacy of merit and quality in manufacturing. Both companies have superb manufacturing facilities, but they are not alone in this respect. There is not likely to be any further trial of the suicidal cutting of prices, from which no one has derived any benefit, not even the public. With their enormous capitalization the two companies must

get decent prices to pay dividends with; and so long as they do that, the electrical trade will have no right to complain. If they do not seek remunerative prices, their early and utter ruin cannot be avoided. As it is, the General Electric Co. must be reorganized, and, perhaps, all the common stock wiped out before its business can be in any shape that a conservative man of affairs not gambling in Wall street would approve of.

GERMAN CENTRAL STATION STATISTICS.

THE statistical tables of the electric light and power industry in the United States have long since ceased to possess that reliability and comprehensiveness which such compilations must have in order to fulfill their object, and even so representative a body as the National Electric Light Association has failed signally in its efforts to place before those interested in the art a reliable record of its magnitude and condition. The chief reason for this unfortunate state of affairs is to be found in the very magnitude of the industry, which now aggregates over 3,000 electric light, railway, and power-distributing stations. The gathering of complete statistics of all these installations would involve a labor and expense of no mean proportions and we hope that future national, as well as State, censuses will eventually put us in possession of the information for all the States, similar to that of New York State, prepared under the direction of Mr. H. A. Foster.

The as yet comparatively small number of central stations in operation abroad has made it possible still to handle their statistics with ease; and among these the German statistics have always been among the most comprehensive and instructive. Our excellent contemporary, the "Elektrotechnische Zeitschrift," in its last issue to hand presents the statistics of German central lighting stations up to Oct. 1, 1895. They are among the most interesting that we have seen in recent years, showing, as they do, the relative popularity of the different systems now in vogue, in a country which has proved by no means conservative in electrical work. The number of stations in operation in Germany at the time mentioned above was 180, as against 148 at the same period a year previous, while it is safe to assume that at the present moment 200 central stations are in actual operation.

The advocates of the continuous-current method of distribution will take much comfort in the fact that that system still remains the favorite in Germany, 80 per cent. of the stations and 74 per cent. of the total capacity being credited to the continuous current. This is indeed remarkable, considering the fact that the polyphase current found its staunchest advocates and first extended application in Germany, over five years ago, a long cycle in the electrical arts. But may we not find a reason for the continuous current's popularity in the fact that of the continuous current stations, no less than 73 per cent. were equipped with accumulators of a total capacity equivalent to 30 per cent. of the engine power? This seems to us more than a mere coincidence, and bears us out in the contention that there are but few situations in which a storage battery could not with benefit be added to the operation of the plant.

Turning to the alternating system, we find that the plain single-phase current has just about held its own, while the polyphase current stations have taken a remarkable jump, so that they now nearly equal in number those operating with single phase, whereas in kilowatt capacity they actually exceed the latter considerably.

The following tabular arrangement brings out more graphically the relative positions of the systems:

	1894.	1895.
Continuous Current.		
Number of stations	120	139
Capacity of stations ....in K. W.	468	35,166
Alternating Current.		
Number of stations	15	16
Capacity of stations ....in K. W.	4,208	4,396
Polyphase Current.		
Number of stations	8	12
Capacity of stations ....in K. W.	2,858	4,468
Polyphase and Continuous Current.		
Number of stations	2	4
Capacity of stations ....in K. W.	646	1,746
Alternating and Continuous Current.		
Number of stations	3	2
Capacity of stations ....in K. W.	175	115

In considering the statistics above it must be borne in mind that more than one-half of the stations have a capacity of less than 100 kilowatts, which indicates the extraordinary economy of operation required in order to make such small stations profitable, and, we think, again gives unmistakable proof of the influence of the storage battery in small central station work particularly.

The 50-watt lamps connected during one year increased from 493,000 to 603,000, or about 22 per cent., while the 10-ampere arc lamps rose from 12,357 to 15,396, or about 24½ per cent., indicating in the latter case a particularly healthy growth, similar to that observable in the United States. But perhaps more marked and significant of all the changes is the increase in horse-power of electric motors connected to the circuits during the statistical year, the capacity of which rose from 5,635 to 10,254, that is, 82 per cent. Though part of this increase is to be credited to electric railway work, the figures nevertheless show an unmistakable appreciation of electric motive power on the part of the Germans.

As regards the character of the motive power employed in German central stations, steam occupies first place, claiming 55 per cent. of the number and 82 per cent. of the power capacity of all the stations. Water power is used exclusively in 23 per cent. of the stations; but these are mostly small stations of less than 100-kilowatt capacity, the combined capacity of which does not aggregate 10 per cent. of the total of all stations. Notwithstanding the popularity of the gas engine in Germany, we find only five stations operated by that method, with a combined capacity of a paltry 265 kilowatt. The advocates of the gas engine for electric lighting must evidently look elsewhere for their shining examples. A glance at the complete tables which occupy six pages of our contemporary makes one sigh for similarly complete tables of our own country. The National Electric Lght Association could in no better way increase its influence than by establishing a permanent statistical bureau, which, once begun, could be kept up with slight effort and expense, and we trust that the matter will receive adequate attention at the convention to be held in May.

ELECTRICAL RULES.

IT is impossible that great good should not result from the insurance and electrical conference held last week, when representatives of all the important national bodies in any way concerned in the promulgation of proper rules for electrical construction and operation, met to discuss and render uniform the rules now existing to govern such practice. The conference was a great success, not only in the character of its members, but in the nature of its deliberations and the importance of the steps taken towards unification. The work that was done was of infinitely greater significance than any mere commercial dicker, no matter how much the columns of the daily press may be loaded with news of the latter. The organizers of the conference deserve much praise and thanks.

The various points taken up by the conference are given in our report elsewhere in this issue. In view of the fact that unanimity and the concurrent action of so many national bodies will give tremendous and decisive weight to the "universal" rules, it is well that no executive powers, for immediate use, were vested in the conference. Such matters as the proper carrying capacity of wires, the grounding of converters and the use of plain iron pipe are not to be disposed of in a casual way. While desiring freedom and cheapness for electrical wiring, we confess our fear of plain iron pipe. If plain pipe, why not bare wire in an insulated pipe? As to grounding converters, that is a ticklish thing. Even now, underwriters protest against the grounding of the neutral in a three-wire system as obnoxious. Then, again, is it not better to go slowly in allowing wires to be loaded, because in England, where different building construction is employed, the heating permissible is higher than here, where everything is so much dryer and hotter to begin with?

The main thing to consider is safety, and the next thing after that is safety; while, if there is any other element to look out for, it is safety. People do not want electric light or electric power or electric heat or electric ventilation or electric cooking or electric elevators, unless each new service is first, and above all, safe.

DEVELOPING DOMESTIC TELEPHONY.

ONE of the recent interesting developments of telephony has been the introduction of the telephone by one local company into the kitchen. For 50 cents a month, the householder can put a one-way telephone into his kitchen, and thus call up the grocer, butcher, coal dealer, florist, plumber or any other retail merchant on the telephone service and give orders. This is a great convenience, and at the rate of less than two cents a day is ridiculously cheap. Besides, it has the advantage of acting as an educator, so that after a short time the user will not wish to limit his conversational resources, but will want to talk to and be in touch with the whole neighborhood. It will be remembered that not long ago one of the New England companies adopted a plan of special temporary service for houses where sickness required the prompt attendance of the doctor. This, again, is but a step towards permanent connection with the exchange and the upbuilding of steady telephonic patronage.

TELEPHONY AND TELEGRAPHY.

THE ERICSSON SWEDISH TELEPHONE.

THE L. M. Ericsson & Co.'s telephone apparatus was first introduced in Stockholm, Sweden, in 1881. Its superior merits were immediately recognized by the General Telephone Company, and adopted by them upon their public service, and in ten years they had 40,000 of them in use. In 1886 the Ericssons reconstructed the General Exchange at Stockholm, placing therein switchboards for 7,000 subscribers. Since then the capacity has been increased to 20,000 drops. This exchange is now considered by some the finest in the world.

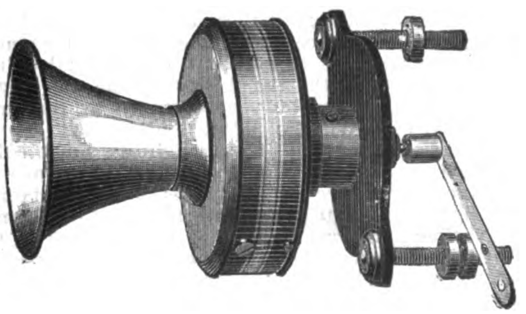


FIG. 1.—ERICSSON TELEPHONE TRANSMITTER.

The Ericsson apparatus is now considered standard throughout Europe, and at a recent test in Japan upon the telegraph line running from Tokio to Kobe, 376 miles, passing through Yokohama, Nagoya, Kyoto, and Osaka, the Ericsson transmitter was found to be the best. The results of the test were very successful, and the government is preparing to open these long-distance lines to the public, using the Ericsson systems. In Germany, Prussia, Norway, and Sweden these telephones are used extensively.

These transmitters have recently been introduced in this country by Williams & Couch, 15 Federal street, Boston, Mass., and used by them upon their improved systems for interior and private line work. They are carrying a large line of the different styles in which they are made, both in the Swedish and American patterns. They import the transmitter direct from Stockholm, Sweden, and are the sole selling agents for the United States.

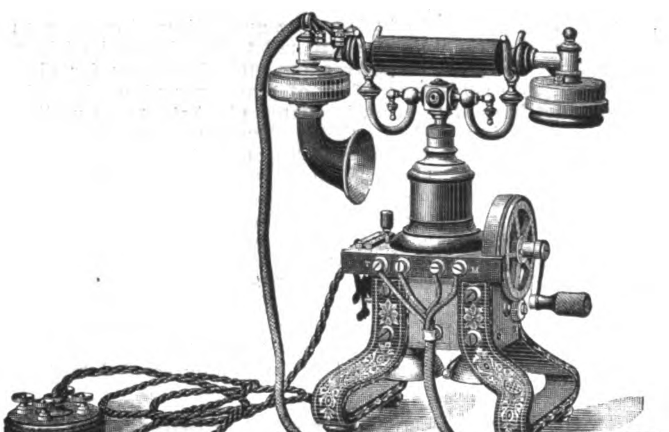


FIG. 2.—ERICSSON DESK TELEPHONE SET.

Fig. 1 shows the transmitter and Fig. 2 a Swedish desk set with hand micro-telephone, while Fig. 3 shows a Swedish wall set.

THE GULF COAST TELEPHONE COMPANY is making rapid progress. Already the line is in operation in Braidentown, Manatee and Orange Ridge, and on its way to Tampa.

INLAND BRAZILIAN CABLE COMMUNICATION.

A telegraph station has been opened at Manaos, Brazil, the capital of the State of Amazonas and the chief emporium of the rubber trade on the Rio Negro, ten miles from its mouth on the Amazon River. Previous attempts to establish telegraphic communication between Manaos and the seaboard by means of land lines have failed. Communication has now been established by means of subfluvial cables in the Amazon. The total length of the river cable is 1,365 miles. The Siemenses have carried out the work.

THE TELEPHONE AT WINDSOR CASTLE.

The Queen has at length decided to put Windsor Castle in direct communication with London by means of telephone. This concession to modern ideas, says the "New York World," is most welcome to the subjects of a sovereign who, even now, prohibits the use of coal, gas and electricity in her private apartments as "new-fangled notions." Some years ago the Prince of Wales strongly urged the Queen to put telephones in all the royal residences, and so seriously did Her Majesty consider the proposition that she sent for the chief representative of a certain telephone company to explain the mysteries of the instrument to her. All went well till the unfortunate agent stated that the person at the other end of the wire responded to a call with:

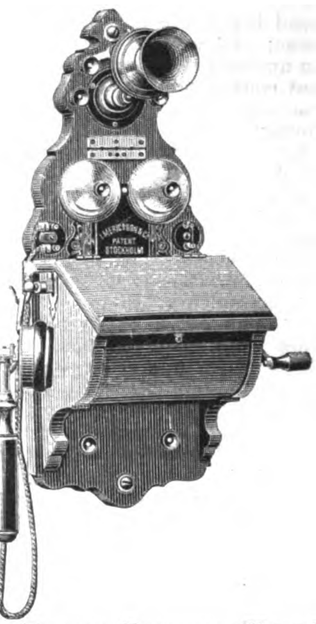


FIG. 3. ERICSSON TELEPHONE WALL SET.

"Hello!"

"What?" interrogated Victoria R. and I.

"Hello, Your Majesty," repeated the blunderer.

The august lady waved her hand to signify that the interview was at an end. She had no further interest in such a vulgar contrivance. That was nearly ten years ago. To-day, however, in view of England's present difficulties, the Queen has waived her objection to the 'phone and permitted the wires to be laid to Windsor. The question of the hour is, What shall be substituted in place of the obnoxious "hello?" "Hail O, Your Majesty," has been suggested.

THE BELL TELEPHONE CO. OF CANADA.

The shareholders of the Bell Telephone Company, of Canada, at a special meeting at Montreal on Feb. 27, authorized the Board of Directors to issue debentures for $600,000 in addition to $600,000 already issued, payable in thirty years, at 5 per cent. The money is wanted to meet various expenses, such as the erection of new buildings, the laying of underground wires in the City of Montreal, and the growth of the business generally, particularly in the matter of long-distance telephoning.

The general meeting of the company was also held. The gross revenue for the year was $1,087,124; expenses, $787,249; net revenue, $299,874. The paid-up capital is $3,168,000. An 8 per cent dividend was ordered paid. The old Board of Directors was re-elected.

EDUCATIONAL.

ELECTRICAL ENGINEERING AT THE UNIVERSITY OF NEBRASKA.

BY T. C. MARTIN.

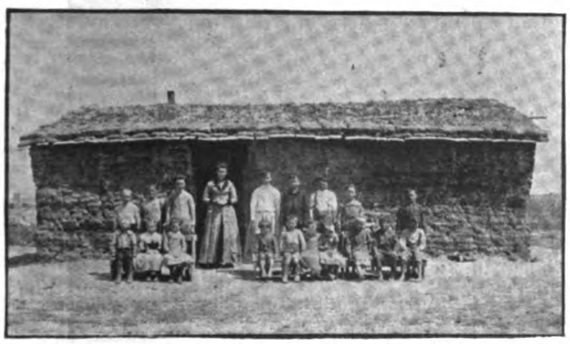
I.

TWO things must strike the observer, in the drift of events at nearly, if not quite, all the seats of learning in this country; and it would also seem that America differs little from more conservative Europe in its educational tendencies. The first of these things is the growing importance of scientific and engineering studies; the second is that electrical engineering is given special prominence and significance in the newer curriculum. With some of us, to whom the time for the study of physics and for laboratory work was grudged, as the recognition of an unworthy ideal, the abundant opportunity now granted freely even for work which requires a student to don a suit of democratic overalls, is looked upon enviously; but there is the grim satisfaction, perhaps, of feeling that after all, while the graduate may be a better engineer than his forefathers had the chance to be, he may have missed something of the sweet and rounding influences of the old "humanities." There are just so many hours in every day, and if they are filled with one study, something else has to go by the board. The net gain, for the present, consists in greater liberty of choice for the student. Later on, probably he and his parents and preceptors will find it well, on the whole, not merely to make an engineer of him, but to turn out, as the foundation for all deeper and specific study, an educated man. This, in turn, implies a longer term of mental discipline, and, best of all, the relegation of higher and special engineering work to a graduate course. Such an evolution is quite easy in places where wealth has accumulated, where education is a heritage of many successive generations, where scholarships and fellowships are abundant, and where the entrance upon professional bread earning is easily postponed; but for many young men and many younger sections of the United States, the problem just hinted at is serious and pressing. What shall a new university do to fulfill the purpose of its existence, and, to be specific, how far can it go in the training of electrical engineers?

PROF. R. B. OWENS.

II.

Here is Nebraska, for example, a State that has been formed and brought into the Union since most of us were born—a State as big as England, with less population than Paris; her people dependent almost wholly on the cultivation of the soil, with no old institutions, no pious founders of colleges, no leisure classes, no millionaires, except those who may yet be. It is readily to be seen that even to provide ordinary education here is no mean task, but when it comes to higher education and then to special training, the outlook would appear hopeless. But they who take pessimistic views do not know the temper of the West. No sooner had these rolling leagues of wind-swept, treeless, black prairie been organized into a State than the university itself reared its first modest buildings; and from that time on the citizens of Nebraska, with a liberal zeal for education that no national endowment of religion ever matched, have taxed themselves through years of prosperity and grinding seasons of adversity alike in order that their children might fight the battle of life on equal terms with the youth of other commonwealths. The bleak winter in which Nebraska set up her standard for higher education by establishing her State University, saw her with barely 100,000 inhabitants. Even to-day she has some 700 sod school houses, humble evidences of a determination that no child shall go untaught, however remote or poor; but she is now laying broad plans for secondary education; and at the upper end of her system is the university, a stately aggregation of modern halls, with 600 alumni, 1,500 students, an income of $163,000 a year; and, best of all, a Chancellor, a Board of Regents, and a faculty, whose ambitions are among the noblest that can stimulate to loyalty and active devotion.



A NEBRASKA SOD SCHOOLHOUSE.

III.

According to figures cited by Chancellor G. E. MacLean, in his profound and inspiring inaugural address before the University, at Lincoln, last February, there were in the State Universities of California, Iowa, Illinois, Kansas, Michigan, Minnesota, Wisconsin, and Nebraska, in 1895, no fewer than 13,500 students, a gain of 320 per cent. over 1885; but during the same period the individual gain of Nebraska was at the rate of 400 per cent., as compared with an average gain in New England colleges of about 20 per cent. This growth would imply not only that the State universities have the hearty confidence of the people, but that successful methods of attracting the right kind of students have been employed. Nebraska has been peculiarly an agricultural State thus far, but she has many other resources to develop, and the growth of population everywhere to-day is so remarkably associated with engineering enterprise that it was early resolved to give a generous portion of her revenues to branches of engineering study. In spite of the difficulties due to a lack of underlying preparatory agencies, from which young men could come familiar with the rudiments of physics, mechanics and mathematics, not less than of languages and literatures, the beginning of the present decade saw the Department of Electrical and Steam Engineering started upon a sound basis. As a matter of fact, this department was an outgrowth from the Department of Physics, and its separate work may be said to have begun in 1891, with an appropriation of $15,000 by the Board of Regents.

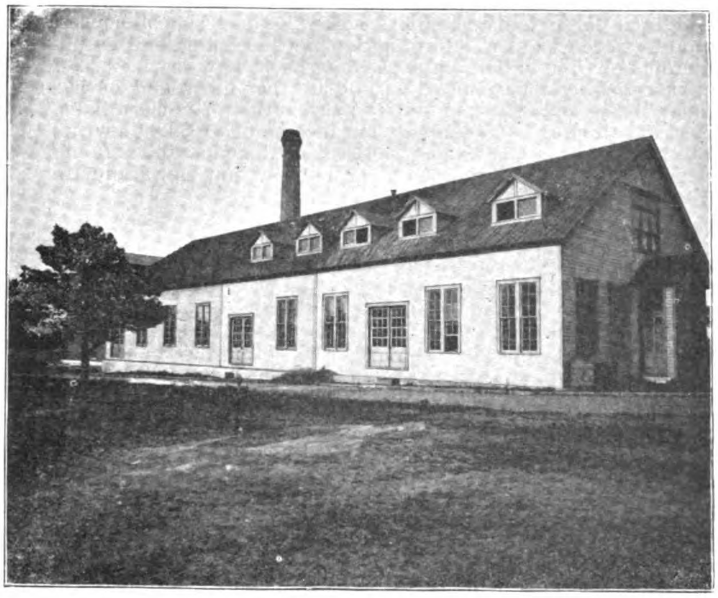
UNIVERSITY OF NEBRASKA. VIEW OF CAMPUS AND MAIN BUILDINGS.

At the present time 92 students are entered for the course in electrical engineering, a number large enough to indicate the popularity of such studies and to provide Nebraska with electrical engineers of home training. The course of study laid down includes thorough work in mathematics, physics and chemistry, applied mechanics, machine design and steam engineering as a basis for the electrical engineering course. Four years, beginning with the freshman year, are required for the Batchelor of Science degree, the last two years of which are devoted especially to electrical work, such as dynamo machinery, electric lighting, electric railways and power transmission, telephone and telegraph apparatus, etc.

From two to three years are required of graduate work for the full Electrical Engineer degree. Throughout the whole work it is attempted to make the student as familiar as possible with the problems he will meet in outside work and to keep him in touch with the latest developments and tendencies.

IV.

The equipment of the Electrical Engineering Department is well illustrated in the accompanying cuts, which show the exterior and interior of the building devoted to its work. The controlling idea has been to make the generating plant fairly represent American engine and dynamo practice, and to have the measuring instruments of such type that reliable commercial tests might be made of all steam and electrical apparatus on hand. Accordingly, it was decided to have both single cylinder, center crank, horizontal and vertical, and compound side crank high-speed engines arranged to exhaust into the atmosphere or to run condensing, and it was also thought best to use shafting as being a method of transmission still in vogue in the majority of American central stations and as affording a ready means of running several dynamos from one engine.



THE ELECTRICAL LABORATORY, UNIVERSITY OF NEBRASKA.

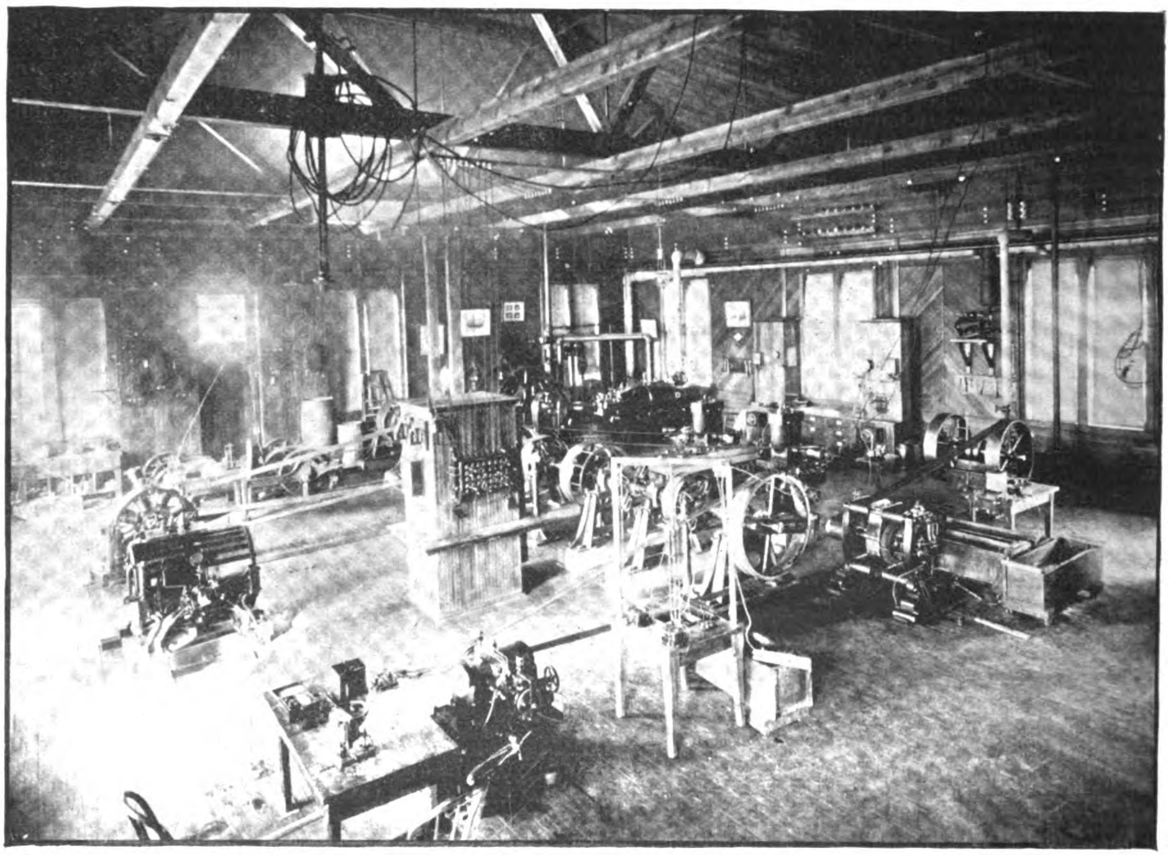
The dynamos include the most important types in general use, namely, low pressure, constant potential dynamos for the two and three wire systems of direct supply; high pressure, alternating current single and multiphase dynamos for long-distance lighting and power; open and closed circuit armature arc dynamos for constant current, together with several inductor machines. To these were added transformers of different makes, alternating and continuous current motors and arc lamps, 500 incandescent lamps, an Otto gas engine of 5 horsepower, together with a storage battery plant of 75 cells of three different makes.

For current measurement by graded instruments, Kelvin balances, Siemens electro-dynamometer and Weston ammeters give a range of from 1 milliampere to 5,000 amperes. For potential measurement by graded instruments, electrometers, Weston and Cardew voltmeters and a Kelvin electrostatic voltmeter give a range of reading from a fraction of a volt to 12,000 volts. Electro-dynamometers, wattmeters by Lord Kelvin, Edelman, Siemens and Weston allow of power measurements from one watt to several hundred thousand. The same range of measurement is provided for in alternating as in continuous currents. Besides the above-mentioned instruments, commercial instruments by the Edison, Thomson-Houston, Fort Wayne and Westinghouse Companies are provided with each system, also the ordinary standard apparatus for magnetic measurements and the measurement of resistance, capacity, inductance, etc., are provided.

For boiler and engine testing, meters, tank and throttling calorimeters, steam, vacuum, and draught gauges, two Tabor steam engine indicators, absorption dynamometers and a transmission spring dynamometer by Van Winkle allow the ordinary tests to be made of boiler and engine efficiency and practice in valve setting, etc.

V.

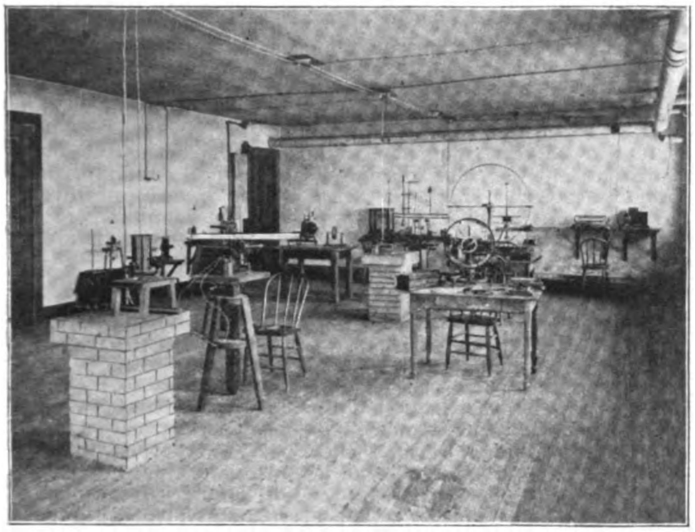
The boiler house is of brick and contains, besides the Stirling boiler for the laboratory, the boilers of the heating plant, feedwater apparatus, coal storage and repair shop. The Stirling



MAIN FLOOR OF THE ELECTRICAL ENGINEERING LABORATORY, UNIVERSITY OF NEBRASKA.

water-tube boiler has a grate area of 27 square feet, a heating surface of 1,150 square feet, and is designed to run continuously at a pressure of 150 pounds and to evaporate nine pounds of water from and at 212 degrees F. into steam at 100 pounds gauge pressure per pound of coal.

The electrical laboratory is built of wood, 50 x 130 feet, with truss roof over machinery, the dynamo room itself being 50 x 60 feet, and the remaining space being reserved for shop work, drawing, and lecture rooms. Sufficient funds not being available at first, it was impossible to build of brick, but a wide foundation was left so that the building might be bricked in and the roof covered with iron or slate at as early a date as possible. The foundations for the engine shafting and dynamos are the best possible, being of hard burned red brick and cement mortar resting on heavy footing courses of concrete. Ample light and ventilation are provided by windows on all sides.



ROOM FOR FINE MAGNETIC MEASUREMENTS.

The shafting in the laboratory is in the center of the building and on the ground, it being thought best not to put it overhead for the double reason of necessitating much more expensive construction of building, as well as being less accessible. The shafting, pulleys, and floor stands were made by the Falls Rivet and Machine Company, of Cuyahoga Falls, O., the shaft being of hammered steel, turned true and polished, 3 15-16 inches in diameter and 33 feet 6 inches long, in three lengths. From it are driven six dynamos, by clutch pulleys, so that any one can be thrown on or off regardless of the rest. The whole shaft can be run from either of the two larger engines or from both together by means of the cut-off couplings. The first driven pulley from the compound engine is bushed with brass and loose on the shaft, but is attached by a dynamometer of the spring transmission type. This dynamometer, by Van Winkle, is keyed to the shaft, and has four springs, giving a wide range of measurement.

VI.

As already noted, there are three engines in this admirable plant. One is a 10 x 18 x 20-inch compound engine, made by the Sioux City Engine Company, Sioux City, Iowa, and designed to run at 125 pounds pressure and 225 revolutions per minute. When indicating 100 horse-power it is guaranteed to show an economy of 25 pounds of steam per indicated horse-power per hour and to regulate within 2 per cent. between no load and full load. The engine has proved very satisfactory in service. The outside fly-wheel of this engine is provided with a two-inch internal flange, so that a continuous stream of water can be kept flowing on its inner side, while an absorption dynamometer is being applied for power measurements.

The second engine is an 8 x 12-inch Atlas and runs at 280 revolutions per minute. Being simple and easily taken apart, it has proved very useful for giving instruction in indicator practice, valve setting, etc. It may be belted directly to single dynamos or to the line shaft with the larger engine The third engine is a small 5 h. p. vertical New York Safety, intended primarily for testing; the throw of its eccentric may be varied, as, also, its angular advance.

To supply water for the condenser there is a large cistern holding about half a million gallons. It is not intended to run the condenser continuously, so that the same condensing water can be used over and over again, time being allowed it to cool down.

On the same side of the shaft with the 3 engines are two 15-k. w. 125-volt Edison dynamos running at 1,500 revolutions per minute. These may be run in parallel, or on the three-wire system; also by a special series winding, any degree of compounding can be had. Both being of the same size and their armature shafts parallel, they may be easily coupled mechanically and electrically and their efficiency obtained under various conditions by Hopkinson's method.

The switchboard for these machines is shown opposite them near the east side of the building. Pulleys of different diameters are provided so that characteristics at different speeds may be obtained and other effects of varying speed studied.

VII.

Coming to the dynamos, the first machine to the left from the large engine is a 1,000-volt 500-light Westinghouse alternator, running at 2,000 revolutions per minute and supplying current to the bank of transformers shown at the north end of the building. This machine is excited by a small United States 110 volt dynamo belted to a pulley on the collector end of the alternator. The switchboard for this machine nearly opposite it contains the ordinary station instruments of the Westinghouse system. A similar switchboard contains the station instruments of the Thomson-Houston alternating system, and the dynamo can be operated through either switchboard at pleasure.

The bank of transformers shown is made up of Westinghouse, National, Slattery, Wagner, Thomson-Houston, and others, from 5 light to 50 light.

The large machine shown on a line with the Westinghouse is a 25 light, 10 ampere Thomson-Houston arc light dynamo, running at 850 revolutions per minute. This machine, together with a 25 light, 10 ampere Wood arc dynamo, driven by the small engine, is connected through lightning arresters and ammeters to a Foster arc switchboard of four circuits, shown between the Thomson-Houston dynamo and the line shaft. Ten ampere single and double carbon, clutch, ratchet, ribbon, and alternating lamps by the Thomson-Houston, Fort Wayne, Excelsior and Westinghouse Companies, are run from either or both the machines and from the alternator. Recently work has been done in the way of changing over the Thomson-Houston machine into a three-phaser, for experimental work.

VIII.

As mentioned before, this laboratory is devoted mainly to engine and dynamo testing and the testing of systems as a whole. The more delicate tests, such as those involving the use of reflecting galvanometers, photometer, work, etc., are done in the Physical Building. The rooms for general electrical testing have piers separate from the building, on which are placed the more sensitive instruments. One room contains the larger number of standard instruments, fixed in position and used for calibrating and the more accurate determinations. The other is devoted more particularly to galvanometer work. Some of the instruments shown in the engravings are Kelvin

LECTURE ROOM, ELECTRICAL ENGINEERING DEPARTMENT.

balances, electrostatic voltmeter, Kelvin quadrant electrometer, Siemens ammeters and wattmeters, large standard tangent galvanometer by the late Troy Electric Manufacturing Company, Obach cosine tangent galvanometer for currents from a fraction of an ampere to several thousand; magnetometer by Edelmann, galvanometer by Queen & Co., earth inductors of Edelmann and Queen & Co., resistance boxes by Elliott and Queen & Co., Cardew and Weston voltmeters, standard cells, standard ohms, etc.

There is an excellent lecture room, besides a private room for the Professor at the head of the department, and every facility is furnished for experiment and demonstration.

IX.

During the recent inaugural exercises at Lincoln, the writer had an opportunity to see the "electricals" at their work and to meet many of them. It was impossible not to be very favorably impressed by such a hearty, sterling, good-natured set of young fellows, so free from "frills," so eager to learn. There seemed to be no trouble in getting work out of them; in fact, a tendency to overdo things was more manifest; and it is a fair inference that a professor in need of stimulus from his charges would here get plenty of it. Many of the men have engaged in special investigations, under guidance, such as efficiency tests on converters, induction motors, etc. One study, that of certain types of arc machines, is to be found in the transactions of the American Institute of Electrical Engineers. Other work in hand the writer would have been glad to secure for the pages of this journal.

To celebrate Dr. MacLean's induction into office, in February, the electrical engineers had organized an exhibition and conversazione of remarkable nature and of brilliant success. The Engineering Laboratory was thrown open to inspection, and the gymnasium was filled with special exhibits, ranging from acetylene and cathodographs to electric cornpoppers and electrolyzed gas pipes. The calcium carbide for the acetylene gas was made beforehand on the premises. Over the campus flew a glittering Franklin's kite, outlined in incandescent lamps, with a flashing tail as long as that of a comet. All this was done with the hearty goodwill of Dr. MacLean, who, though a former professor of literature at the University of Minnesota, shows himself most anxious for the prosperity of the engineering studies.

X.

It is proper, in closing this brief review of the splendid work thus being done by a Western university in higher technical education, to note that the success already reached must in no small measure be attributed to Professor R. B. Owens. No elderly man would have cared to take up the task that he assumed some five years ago of organizing the new department; but even in a country where youth is counted chief among the virtues, it is a little surprising to see the responsibility resting upon the subject of this personal note. Professor Owens might in a sense be taken as typical of the energetic New South, for he was born on a plantation in the southern part of Maryland, a State of which his mother's great grandfather was the first Democratic Governor. He spent three years in an old military school of Maryland, and was the youngest to graduate since its founding in 1774. After a brief connection with the old Baxter Motor Company, he resumed study at Johns Hopkins University, under Dr. Louis Duncan, and stood well in mathematics and physics. He was then for a time with the Excelsior Company in New York, and put in and superintended the Thomson-Houston station at Greenwich, Conn. Study was not neglected, mean time, for in 1891 he received the post-graduate degree of E. E. from Columbia College, in the first class to receive it in America, having been a student under Professor Crocker. When the University of Nebraska wanted to make its new departure, Mr. Owens was invited to go out there, and he was made Adjunct Professor of Electrical Engineering. In 1894 he became full Professor of Electrical Engineering, and in 1895 he assumed full charge of the Department of Electrical and Steam Engineering. He was a member of the International Electrical Congress of 1893, and a Judge of Awards in Electricity at the Columbian Exposition of that year. He is a member of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers. Prof. Owens' forte strikes one as that of organization. He is moreover appreciative of the practical and commercial side of engineering, and while he encourages his students to grasp theory with full realization of its meaning, he aims also to make them take hard-headed views of the problems of engineering, as they are to be found, in actuality, on the prairie floors and broad rivers of the Central West.

XI.

As an example to other manufacturing concerns the writer cannot refrain from adding here a list of apparatus that has lately been loaned or given to the department: Thirty-light arc dynamo and 30-arc lamps, the Excelsior Electric Company, New York, N. Y.; Fleming alternating arc lamp, Fleming-Spence Electric Company, New York, N. Y.; automatic welder and reactive coil, Thomson Electric Welding Company, Lynn, Mass.; two 20-light transformers, Wagner Electric Company, St. Louis, Mo.; 30-light transformer, Lakon Electric Company, Chicago, Ill.; electric welded rail joints, the Johnson Company, Johnstown, Pa.; tested samples of iron and steel, Carnegie, Phipps & Co., Limited, Pittsburg, Pa.; tested samples of steel pipes, Riverside Iron Works, Wheeling, W. Va.; parts of boiler, Harrison Safety Boiler Works, Philadelphia, Pa.; standard pump in section, Knowles Pump Works, New York, N. Y.; sample boards of wires and cables, J. A. Roebling's Sons Company, Trenton; sample boards of wires and cables, Standard Underground Cable Company, Pittsburg, Pa.; sample boards of interior conduit, Interior Conduit and Insulation Company, New York, N. Y.; storage cells and sample elements, Electric Storage Battery Company, Philadelphia, Pa.; heating and cooking apparatus, Western Electric Heating Company, St. Paul; 60-light dimmer, Iron Clad Rheostat Company, Westfield, N. J.; 2½-horse-power, 110-volt electric heater, Automatic Switch Company, Baltimore; boards of standard instruments in parts, Weston Electrical Instrument Company, Newark, N. J.; slide valve model, boiler tube expander, Sioux City Engine Works, Sioux City, Iowa; street car truck and motors complete, Lincoln Electric Railroad, Lincoln.

It will be seen that the catalogue enumerates some very substantial items. There is no place to which material can be given with better judgment than a college or university, where eager young minds can grasp its principles and where the students if they find it meritorious at once become its ardent friends and advocates.

CORRESPONDENCE TECHNICAL SCHOOLS AS PREPARATORY TO RESIDENT TECHNICAL SCHOOLS.

BY E. P. ROBERTS.

THIS article was suggested by a conversation between a technical journalist and a professor of electrical engineering in a technical school, which school is especially well equipped to give an admirable laboratory course, but has to labor under the usual disadvantage of having a large portion of the course, as now given, necessarily devoted to such studies as must precede laboratory practice.

If students had sufficient preliminary education, the special advantages obtainable from a college course could be utilized to a far greater extent, and the student of the four years' course could attain the same plane as is now reached by the student completing his course, and afterwards taking one year post-graduate work in the laboratory. That the standard for admission can be so raised as to make this possible, does not seem practicable at the present time; nevertheless, there are students who have had such preliminary education as to enable them to accomplish the above desired result; they are able to "pass up" their mathematics and other studies, and to devote the time saved to laboratory practice, in some cases obtaining all the advantages of a four years' course in three years, and in other cases obtaining the greater advantages of the five years, above mentioned, in four years.

Of the students who manage to enter college, there are many who have had very insufficient preparation, and who either fail or drag along in a manner which, possibly, is worse than failure. Of the students who enter technical schools, there are very few who have at all an adequate comprehension of the professional life of an engineer, and of the great advantage to be derived from a thorough training in the principles upon which correct engineering practice is based. Because of this, many students consider the studies, more especially those of the first two years, as tasks rather than as advantages to be grasped. They cannot see any practical application to be derived from the knowledge which the instructors endeavor to impart, and, therefore, to a very considerable degree, they will not use their utmost efforts to thoroughly master the same. If, however, before going to college they had become acquainted with the application of the principles of mathematics and physics to the solving of engineering problems, and comprehended, at least to some extent, the great advantage to be derived from a thorough knowledge of the laws of nature, and the mathematical expressions involved in the application of such laws the probabilities are, that they would devote their best energies to obtain all the benefits possible from their college course, and especially would they be able to take full advantage of the laboratory facilities.

Probably each class in a technical school has some members who have worked in machine shops, drafting rooms, or in the field, before going to college. Such men are often not the brightest or the most showy, in the first year or two of their college work; but, because of the energy with which they devoted themselves to their studies, and, also, because at the same time that they are obtaining instruction in theory, they are amalgamating with it practical application, it is found that, either before they have completed their course, or shortly after they have gone into the practice of their profession, they are in advance of their colleagues.

In addition to those able to take a complete college course, there are many who can merely afford time and money sufficient to spend one or two years in college. Such students are

termed "special students," and, as a general thing, their career is not satisfactory, either to themselves or to their instructors. Possibly the principal reason for this is that the special desire of such students is to obtain laboratory practice, and this their preliminary education does not enable them to do. There are now correspondence technical schools which give instruction on technical subjects, and also on the necessary preliminary and allied studies, and in advanced mathematics. The courses in such schools are proving of value, not only to those who cannot go to college, or who desire instruction in a different branch from that which they followed at college, but also in enabling the student preparing for college to obtain such an education as will enable him to realize and take advantage of the college facilities.

A student can obtain the mathematics, physics, mechanical drawing, etc., necessary not only to pass an entrance examination, but also sufficient to carry him a considerable distance into this course; and by devoting the time otherwise spent on such studies when at college, he is enabled to employ his time in laboratory work. He also, if he so desires, obtains a preliminary education in the engineering specialty which he expects to follow, and, as he proceeds with the college studies, he appreciates the advantages which may be derived from them, largely because he can note the practical application. If he takes a special college course, he has had such an education as enables him to spend his time at college to far better advantage than would otherwise be the case.

That correspondence instruction is a success is known to thousands who have obtained either their entire education or a very considerable portion of same by such methods. It is probably unnecessary to state that, in order to obtain the full benefits of such a method, a student must be in earnest, be willing to devote his time to study, and not be satisfied with the mere enrollment of his name in some technical school. It has been abundantly proved that, for those who are in earnest, correspondence instruction has resulted in a thorough education; and in addition to the knowledge of principles and facts obtained, there has also been developed in the student a self-reliance and faculty for the accurate and systematic expression of his knowledge to an extent not surpassed, at least, by any other method.

The correspondence technology school therefore offers to the man desiring to go to college (1) a means of preparation, and (2) a means of so preparing as to enable him to obtain greater value from a college course than if the preparation were for entrance only.

As this article deals only with the subject stated in its title, the advantages of a correspondence technical school to those not having had a technical education, or to those whose education was along a different line from that being followed, or to those who desire to be in touch with specialists in that study in which they themselves are specialists, will not be discussed. The correspondence technical school is of assistance to any one intending to follow or practicing engineering.

SPECIAL LECTURES AT THE STEVENS INSTITUTE OF TECHNOLOGY.

It is the intention of the Board of Trustees of Stevens Institute of Technology to present, from time to time, prominent men who will lecture on various subjects which are of especial interest to the mechanical engineer, but not included in the regular course of study at the Institute. The first of these special lecturers, Mr. Richard N. Dyer, of New York, has just concluded a series of three lectures on "Patent Law."

PERSONAL.

HON. GARDINER C. SIMS contributes to the Providence "Journal" a very interesting summary of the facts in regard to the Nicaragua Canal, and presents several strong arguments in favor of the canal as of benefit to American trade and commerce. Mr. Sims is the antithesis of a Jingo, but believes ardently in the extension of commercial opportunities.

MR. THOMAS F. O'CONNOR, who has been nine years connected with the Standard Underground Cable Company, has just resigned from that company to accept the position of Assistant General Manager of the National Underground Cable Company. Mr. O'Connor has been in the underground cable business from its infancy, has seen it grow to its present proportions, and has aided much in that growth. Outside of his broad experience in the underground cable business, in which he is an acknowledged expert, Mr. O'Connor is well known as an inventor in mechanical as well as electrical branches, and he has also the rare advantage of having taken a three years' law course in the University of the City of New York.

SOCIETY AND CLUB NOTES.

ROENTGEN RAYS.[1]

BY MAX OSTERBERG, E. E., A. M., FELLOW OF COLUMBIA COLLEGE.

THE author introduced the subject by a short, but admirable, résumé of the work and researches of Faraday, Maxwell, Hittorf, Crookes and Hertz, which had led up to the discovery of the "X-ray" by Röntgen. The author then continued:

All these points have been verified years ago, and when Hertz commenced to work with vacuum tubes, he was well aware of these properties. He added a valuable suggestion to the work, which Philip Lenard, now professor at Breslau, but at that time privat-docent at Bonn, carried out in a most conscientious and admirable manner. Hertz found that very thin filaments of gold leaf were transparent to cathode rays, for he succeeded in making glass phosphoresce when separated from the cathode by means of a gold leaf. Lenard then made the next step. He suggested investigating whether phosphorescence could be observed outside of the glass tube, and for that reason he sealed a piece of aluminum to one terminal of a glass cylinder, forming what he called an aluminum window. He actually observed phosphorescence outside of the aluminum window, but he could affect a plate only through a distance of 6 cm. He was positive that he had nothing but cathode rays, for he could deflect them by a magnet, just as he could those inside of the glass tube. If he rarefied the air outside of the aluminum window, he could easily increase the distance through which fluorescent plates could be affected. Lenard made use of this observation to draw the very interesting conclusion that cathode rays are not due to radiant matter or Crookes' fourth state, but that it was a property of the ether, a view which had been held by several German physicists without the support, however, of any experiments.

Lenard did a great deal more and valuable work. He determined, for example, that the absorption of the rays which he observed was proportional to the density through which they were passing; he showed that by compressing hydrogen until it had the same density as oxygen, the absorption of both would be the same; but, here comes one of the most essential points to be considered. He was not aware that he had any other but cathode rays. I actually regret to be forced to make this statement, but in these times when scientists make it their chief aim to achieve privileges of priority, they must also be willing to accept a reproach for work which does not directly help to advance.

Thus we have arrived at the essential point of the lecture: At the question, what is the Röntgen ray? I may be pardoned, I trust, for not using the term X-ray, the word used by Prof. Röntgen in his now celebrated lecture, but he availed himself of this term only to distinguish it from the light rays about which he spoke, and probably also to allude to the undetermined nature of the same. To make an attempt to explain the nature of the Röntgen rays and then to state its manner of manifestation, would be working against the natural law of historical development which I have tried to follow up to the present time. We will therefore take up its characteristics.

In order to present the subject to you in as clear a manner as possible, let us compare the properties of the Röntgen ray, whenever possible, with the cathode and Lenard rays; for then, whenever a new feature is introduced, we can more intelligently appreciate it. Any highly exhausted tube, through which the electrical discharge takes place, may be covered with a piece of black paper or thin cardboard, and it will be observed, in a perfectly dark room, that a fluorescent screen, that is, any surface which has been coated or washed with barium platino cyanide, for example, will light up brilliantly and fluoresce equally well, whether the treated side or the other be turned towards the apparatus. This fluorescence is observable through a distance of two metres. Thus we have a phenomenon here, which shows that phosphorescence can be observed through one piece of glass, that glass, however, being the surface of the Crookes' tube and one or two pieces of cardboard. Lenard only found fluorescence in the direction of the aluminum window; Röntgen observed his effect for a distance of two metres; Lenard only through a distance of 6 cm.

Prof. Röntgen tried to deflect the new rays by means of a magnet, as Lenard deflected the cathode rays, but he found it impossible to do so. This introduces an essentially new property—one of the utmost importance.

An attempt to deflect the cathode rays in the tube, which

[1]Abstract of a lecture delivered before the New York Electrical Society, Thursday, March 19, 1896.

produced the phosphorescence on the surface of the glass, showed that in this case the direction of the Röntgen ray would be changed, but only inasmuch as it went forth in straight lines from the spot in which the cathode rays were concentrated. This led Prof. Röntgen to the conclusion that the new ray was generated on the surface of the glass by the cathode, but shortly afterwards he found that an aluminum cylinder, excited by means of the discharge apparatus, will also excite the Röntgen ray. This would lead one to the conclusion that there are no Röntgen rays inside of a Crookes tube, and Prof. J. J. Thomson, in England, made an experiment to prove the correctness of this assertion, which was generally accepted, not only as extremely ingenious, but also as conclusive. To this, however, I cannot agree. Ingenious as it appears, it has no practical value, for the negative result which it obtains is not by any means a proof of the non-existence of the rays inside of a vacuum.

Prof. Oliver J. Lodge, in a contribution to the London "Electrician," Feb. 7, 1896, wrote: "J. J. Thomson has exposed a protected plate in the very rays themselves inside the vacuum and got no result. It looks as if the streaming particles alone could not achieve it." It appears that Professors Thomson and Lodge, and, in fact, a great many others, are not aware of the fact that a highly sensitized plate ceases to respond to the influence of light when inside of a vacuum. In order to act photographically on a sensitized plate, it takes a certain amount of moisture, extremely little, to be sure, as little only as will be in the atmosphere at any time, even in the driest condition, but more than in as perfect a vacuum as is required to generate the Röntgen rays. Now, if a sensitized plate is not even fogged by light it may well be possible that the Röntgen ray develops no actinic effect.

Various other experiments, the details of which I need not now enumerate, led to the conclusion that the transparency of different substances of the same thickness is mainly conditioned by the density, a result similar to the one found by Lenard with his rays. A very carefully carried out experiment, however, showed that density is not alone in its influence; for glass, aluminum, calcspar and quartz all have about the same density, while their transparency for the Röntgen rays varies widely.

Röntgen rays are found to travel in straight lines; they cannot be reflected nor refracted; thus they cannot be focused like light rays, and hence any picture which is made on a sensitized plate will not be a photograph in the true sense of the word, which means the fixing of a real image, but it will simply be a shadow picture, showing the differences between the more and less transparent substances. Thus it happens that the bones of the human hand can be plainly shown, since flesh is more transparent to Röntgen rays than the bones, but, by over-exposing a plate, you can make the bones disappear, too, and if any solid substances harder or denser is inside of the bone, it will then be easily discovered. Dr. Pupin has demonstrated this very conclusively in a shadow picture, a slide of which I shall show you this evening.

Another discovery recorded by Prof. Röntgen is of great interest, for several investigators, American and European, apparently discovered it independently, but, at any rate, later than Prof. Röntgen. Both these gentlemen might have saved themselves the trouble, however, if they had read more carefully the following lines in Röntgen's lecture:

"If the hand is held between the discharge tube and the screen, the dark shadow of the bones is visible within the slightly dark shadow of the hand." This is a very short but precise statement, and, since the beginning of his paper, Prof. Röntgen spoke of working in a dark room with black cardboard over his tubes, his process is completely defined. If he can thus see bones through the hand on the fluorescent screen, there is no reason why he should not see the movement of joints.

Mr. E. P. Thompson, of this city, has published a very ingenious and interesting device for doing that same thing and called it a kinetoskotoscope, and Prof. E. Salviono, in a communication made to the Medico-Chirurgical Academy of Perugia, on Feb. 6, 1896, has described a similar arrangement, which he called a cryptoscope. Although the respective boxes and arrangements of both these gentlemen may be new, the discovery itself belongs again to no one but Prof. Röntgen.

Now it remains to discuss the various experiments made by others than Prof. Röntgen since the announcement of the discovery, and to investigate in which way different methods have been introduced. I will not pay too much attention to the work reported in the daily papers, which, although it may be correct, lacks the guarantee of exactness which the recognized technical journals give it. In the first place, we must consider the method of generating the Crookes' tube discharges. In his lecture Prof. Röntgen mentions the use of a Ruhmkorff coil; this simple device alone, however, will not, according to various experimenters, produce the best results.

Dr. Pupin has used in connection with his induction coil in the very beginning of his experimental work an oscillatory discharge and a disruptive spark gap; of late, however, he has introduced a new device, which, judging from the good shadow-pictures obtained, works remarkably well. He kindly loaned it to me this evening, thus giving me an opportunity to explain and show it to you. It consists simply of a direct current motor with a make and break commutator. Whenever the circuit is broken the intensity of the current is greater than when the circuit is closed, and since this make and break takes place about sixty times per second, we get very powerful effects at the cathode of the tube. Dr. Pupin found this device preferable to the ordinary make and break device in the induction coil because there is no sparking at higher frequency. The little sparking which would be apt to appear at the commutator is taken up by a condenser in the circuit. Mr. Tesla has also used the oscillatory discharge and the spark gap, which, by the way, is the invention of Prof. Hertz, who communicated it in a paper in "Wiedemann's Annalen" in 1887. The Holtz and Wimshurst machines, which have been considerably used, have also shown their efficiency in this connection.

The next important point is the vacuum tube. A person experimenting with the Röntgen rays should post himself thoroughly on the work done by Hittorf, Pluecker, Elster and Geitel, Spottiswoode, Crookes and others, and he will save himself much trouble, for these men have made as careful a study as possible of the manifold phenomena which present themselves when experimenting with these tubes, and many puzzling questions are discussed and partly solved by them. To mention but one of the most interesting and at the same time most annoying occurrences. When a very perfect tube is used with a vacuum it is found to actually improve, when the discharge takes place for any length of time, that is, the tube will require a greater pressure at its terminals to allow the discharges to take place, and after a while the resistance of the tube becomes so high that no spark can be made to go through. Suppose that you take the same tube and use it with an induction coil with a rather large number of makes and breaks, it may again for a time be used; then it may again be used for a short time on the induction coil with the oscillatory discharge in its circuit. After that, air must be let into the tube and the tube re-exhausted.

This phenomenon was observed some weeks ago independently by Dr. Pupin, Mr. Tesla and Mr. Edison, but, as a matter of fact, it is not new, for Crookes, as well as Spottiswoode, knew of it and mentioned it in the "Philosophical Transactions" many years ago. Mr. Tesla bows submission to a theory of actual mechanical expulsion of material particles through the walls of the tube. Edison, on the other hand, believes that the electrodes which extend into the tube, absorb the remnants of the gases contained in the bulb, thus increasing the actual ohmic resistance between the terminals and at the same time making a higher, that is, more perfect vacuum. For my part, I must say that this explanation appears more plausible, for a few weeks ago I used a tube without any electrodes on the inside, but simply two pieces of tinfoil on the outside, but found no such change, showing that the electrodes apparently play an important part in this phenomenon.

I finally come to the sensitized plate. Very little is to be said in this connection as yet, but there is great room for improvement. It appears that a plate which is very sensitive indeed, that is, an instantaneous plate, for ordinary light is not nearly as sensitive to the Röntgen rays as a landscape plate, which remains exposed to the light for a long time. The reason for this probably lies in the fact that a plate sensitized for violet and ultraviolet rays has not as high phosphorescing qualities as plates sensitized for the opposite, or red part, of the spectrum. Mr. Edison has made some interesting experiments in connection with different plates, and the statement just made is based on his results.

Shortly after Röntgen's announcement, it occurred to many people to investigate whether the Röntgen rays would also be found in sunlight or in the electric arc. I will make no attempt to state who first suggested this idea, for, in the first place, it would be too difficult, in the second place it is useless. The question itself is of great importance, for a definite solution would answer such conundrums, as whether the ray requires a vacuum for its generation, whether the cathode rays must be developed, etc. I have a few slides of pictures, taken by Mr. W. H. Freedman, which clearly demonstrate what I want to explain. His results show, beyond a doubt, that the effect obtained is only due to filtration of light. Thus he found, for example, that glass which casts a heavy shadow to Röntgen rays, casts none whatever in any of these instances; furthermore, he found that when the plateholder used was closed with an aluminum slide, instead of hard

rubber, no shadow picture was obtained. The aluminum slide used was only .01 of an inch thick, and is quite transparent to Röntgen rays. Finally plateholders were placed so that the rays of light struck them at an acute angle. In no case was a shadow picture obtained, showing that reflection took place, and proving the absence of Röntgen rays.

Finally, it remains to say a few words on the theory of the new ray. Prof. Röntgen is of the opinion that we are dealing with longitudinal waves of the ether. Up to the present time we have assumed that ether only allows light rays to travel through, and, since we know that light rays progress by means of transverse waves, we have ascribed to the ether such properties as are required to fulfill the conditions for transverse wave propagation. An incompressible fluid, for example, is a substance which allows only a transverse wave to travel through it. We mean by that a wave whose particles move perpendicular to the line of propagation. If it has now been found that there are also longitudinal waves, it simply means that the ether is not absolutely, but simply nearly so, incompressible, for a compressible substance is capable of transmitting a longitudinal wave, or one in which the particles move in the line of propagation.

To speak in detail on these theories, or on the manifold applications to which the new discovery may be put, is at present quite useless; suffice it to say, that when the years roll by and the discoveries of our times are recorded in the annals of history, one of the characteristic endowments to science will be the epoch-making work of Wilhelm Konrad Röntgen.

The lecture was interspersed with a number of experiments, in which the production of X-rays by the use of Crookes' tubes was fully demonstrated, various forms of tube being used. A number of lantern slides were then exhibited, made from cathodographs taken by Mr. Edison, Dr. Pupin, Dr. W. J. Morton and others. Mr. Edison's showed the permeability of different substances. In one of Dr. Pupin's, a hand was shown, in which 72 small shot and fragments were embedded. One of Dr. Morton's cathodographs was a picture of Sandow's foot, in which splinters of glass had lodged, and for which the great athlete had been under treatment. Mr. Ker threw on the screen a series of pictures he had secured by arc light, illustrating phenomena, to which he makes reference in an article in this issue of "The Electrical Engineer."

The lecture was discussed by President Lieb, Mr. N. W. Perry, Doctors Morton and Pupin, Mr. Ker and the President of the New York Camera Club. The audience filled the Chandler lecture room to overflowing. After the meeting Dr. Pupin exhibited to some friends in his laboratory some recent magnificent cathodographs he had taken, one of which was 18x22 inches, and showed the whole arm and hand, and showed also the curious phenomenon of three separate but blended pictures, evidencing activity at both ends of the working tube and at some other indeterminate point.

MR. N. W. PERRY ON THE UTILIZATION OF CULM.

Mr. N. W. Perry, editor of "Electricity," lectured at the Franklin Institute on March 13, on the utilization of the culm piles which have been accumulating about the anthracite coal mines, and which are now occupying valuable space.

This culm, or the finer portion of it, is almost entirely pure carbon. It is mixed with coal of all sizes, from bird's-eye up to stove size. In this condition it is not an economical fuel, as the finer portion burns first and the larger is wasted with the ashes. It can only be used as a fuel economically at or near the banks, for hauling or handling it increases its cost, delivered, to a point approximating that of a graded coal.

It is estimated that 20 per cent. of all the coal removed from the mines is in the culm banks, which are now veritable mountains. A commission appointed by the Governor of Pennsylvania, comprising some of the best mining experts, reported that these banks contained not less than 315,700,000 tons of coal. In the Scranton district alone there is an annual deposit of culm of 1,400,000 tons, or the equivalent of a stream of energy of over 75,000-horse-power—fully three-fourths of the energy of the great water power tunnel at Niagara Falls.

The speaker described what is known as the Dowson process of converting this fuel into a fuel gas, which, with coal at $4.50 per ton, would cost but 6 cents per thousand cubic feet. The fuel is burned in a furnace with the blast produced by a steam injector. One ton of good anthracite coal will produce 150,000 feet of a fuel value about one-quarter that of 16-c. p. gas. This, he believed, could be produced at the nearer coal fields, and piped to Philadelphia with economy.

The lecturer said energy in this form could be much more cheaply transmitted than the same amount of energy could be transmitted electrically. His comparisons, however, were made with electricity at low pressures, 110 and 220 volts, and 1,000 volts, and at these pressures it was easily shown that at the distance of a mile the gas would be the more economical at pressures not exceeding 4 inches of water pressure. No comparison was made for long distances or with a high voltage (say 30,000 volts) and an alternating current.

The lecture concluded with lantern slides showing the culm banks, and the various kinds of furnaces for producing fuel gas and grates for burning small coal.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The 104th meeting of the Institute will be held at 12 West Thirty-first street, New York city, on Wednesday, March 25, 1896, at 8 o'clock P. M. Prof. Wm. L. Puffer, of Boston, will present a paper entitled "A New Method of Studying the Light of Alternating Arc Lamps." It will be accompanied by experiments. A meeting of Western members will be held the same evening, Wednesday, March 25, at 8 P. M., at the Armour Institute, Thirty-third street and Armour avenue, Chicago. At the latter meeting the subject will be "The Röntgen Phenomena, Theory and Experiments." It will be presented by Mr. Charles E. Scribner and Dr. James D. Burry, assisted by Prof. W. M. Stine.

MISCELLANEOUS.

MEETING OF THE NATIONAL CONFERENCE ON STANDARD ELECTRICAL RULES.

AT the invitation of the Committee on Standard Rules of the National Electric Light Association, a conference of the various interested bodies was held March 18 and 19 at the headquarters of the American Society of Mechanical Engineers, No. 12 West Thirty-first street, New York City. The meeting was called to order by Mr. Wm. J. Hammer, chairman of the Committee on Rules of the National Electric Light Association, who stated the object of the meeting, which was to harmonize as far as possible the various interests, and, if possible, to produce a standard set of rules for electrical construction which would be recognized and accepted by all who were engaged in such work. He also announced a list of those representatives and associations who had been invited and were therefore entitled to take part in the present conference.

The following representative members responded to roll call: Professor Francis B. Crocker, American Institute of Electrical Engineers; Frank R. Ford, American Street Railway Association; William H. Merrill, Jr., National Board of Fire Underwriters; A. S. Brown, Western Union Telegraph Company; Francis W. Jones, Postal Telegraph Company; Alfred Stone, American Institute of Architects; Capt. Wm. Brophy, National Association of Fire Engineers; C. J. H. Woodbury, American Bell Telephone Company; Lieut. S. Dana Greene, General Electric Company; Charles F. Scott, Westinghouse Electric and Manufacturing Company; E. A. Fitzgerald, Underwriters' National Electric Association; E. V. French, Factory Mutual Insurance Association; Wm. J. Hammer, chairman, Wm. Brophy, Harrison J. Smith, James I. Ayer, National Electric Light Association Committee on Rules.

Also the following complimentary delegates and advisory experts: A. E. Kennelly, E. E., Philadelphia; Wm. McDevitt, E. E., Philadelphia Fire Board; W. J. Jenks, E. E.; E. H. Johnson, Interior Conduit and Ins. Company; Morris W. Mead, superintendent of the Bureau of Electricity, Pittsburg (afterward admitted as a representative of the National Board of Fire Engineers in place of Capt. Brophy, who was already on a committee of the N. E. L. A.).

The following visitors were also in attendance: C. H. Wilmerding, president of the N. E. L. A; Mr. Holloway, late president of the American Society Mechanical Engineers; Professor Hutton, secretary of the American Society of Mechanical Engineers and others.

Upon motion Wm. J. Hammer was made permanent president of the conference and C. J. H. Woodbury, secretary. Upon invitation of President Hammer, Mr. C. H. Wilmerding then addressed the meeting which he did in a few well-chosen remarks. He hoped that the various interests represented would agree upon a uniform code and further suggested that in order to make their work permanent and keep up with changes which experience or changing methods found necessary, that the organization as assembled should be made permanent. Mr. Wilmerding's remarks were well received. Upon motion a committee was appointed to consider the question of permanent organization, namely, Alfred Stone, Francis B. Crocker, Wm. Brophy, Wm. H. Merrill, S. D. Greene, C. J. H. Woodbury. The following committees were also appointed; By-

Laws, Crocker, Merrill, Brophy; Wiring Rules, Crocker, Ford, Merrill, Stone, Fitzgerald, Brophy, and French.

The committee on permanent organization later reported unanimously in favor of such a plan, and that only national bodies be represented, but that manufacturing or supply companies might be admitted as associate delegates without the right to vote; the organization to also have the right to avail itself of the advice or experience of experts in their various capacities.

The report was adopted and the secretary instructed to extend to other national bodies not now represented an invitation to send representatives to future conferences.

Under this decision future conferences will be composed as follows if the invitations are all accepted:

American Institute of Electrical Engineers, American Street Railway Association, National Board of Fire Underwriters, American Institute of Architects, National Association of Fire Engineers, Underwriters' National Electric Association, Factory Mutual Insurance Association, National Electric Light Association.

Invited—American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining Engineers, American Society of Naval Architects and Marine Engineers, National Master Builders' Association.

Associate Members—Western Union Telegraph Company, Postal Telegraph Company, American Bell Telephone Company, Westinghouse Company, General Electric Company, and others.

Through the courtesy of the American Society of Mechanical Engineers, the building at No. 12 West Thirty-first street, New York City, was made permanent headquarters, where communications of interest to the committees or conference can be addressed.

CAPT. BROPHY read a paper on the history of attempts at formulating standard rules by the National Board of Underwriters and others. The present attempt to standardize rules is the second attempt of this kind, a similar meeting having been held in Cape May, in May, 1890. That meeting formulated a set of rule that were satisfactory to all interests at the time, but a second meeting of this kind has never been called until the present one.

MR. JENKS spoke in the same strain and expressed the opinion that as far as possible rules should be few and simple and should be rather prohibitive than educational; that they should rather say what should not be done, than to issue a set of instructions to incompetent wiremen; in fact, a set of insurance commandments. The opinion was also expressed that we should avoid the error of the English Board of Trade, which hedged the new industry with so many rules and restrictions that development and improvements were almost impossible and electric lighting became an expensive luxury. We should rather strive to encourage than throttle the young industry.

The conference then took up the subject of rules. In this connection it might be mentioned that six different codes now in use were shown at the meeting, viz.:

National Electric Light Association, National Board of Fire Underwriters, Associated Factory Mutual Insurance, English Board of Trade and Phoenix Rules (new); German Code (new); Edison Illuminating Company.

The first four codes were printed for the use of the conference in one book in parallel columns for comparison. The set of rules issued by the Factory Mutuals is a model instruction book, and was evidently written for the information of factory-owners. Almost every rule is accompanied by explanatory notes as to the reasons for such rule, and in some cases authorities are quoted. The rules follow closely those of the National Board of Underwriters for 1895. The first three codes mentioned are very similar, but that issued by the N. B. F. U. showed more careful study in its construction than the others, and was taken as a standard with which the others were compared.

One point brought out in the discussion was that the rules of the N. B. F. U. were primarily composed with reference to the first risk involved, while those of the N. E. L. A. had in view good construction. While the two objects are similar, they are not always the same. Thus a circuit might be run in such a manner as to be a safe fire risk, but very poor construction from an electrical point of view; while, for example, wires fastened to woodwork may be good electrical construction, yet, for well-known reasons, insurance men could not generally indorse or allow that kind of work.

MR. MEAD spoke of the means of enforcing these rules by legal and political means. In all cases where wiring came under the control of civic authorities the various boards should have this code of rules brought to their attention and adopted. In some cases it will be necessary to use political influence to accomplish this, but as a general thing they would be adopted without question, but penalties should be provided for their violation.

CAPT. BROPHY spoke of the Massachusetts law, which compels all cities to appoint an inspector of wires. They hoped in this way to weed out those who were not legitimately in the business. They undertake work that they are not familiar with at prices which freeze out responsible contractors and skimp the job to save themselves from losing money.

MR. A. E. KENNELLY read a paper on the safe carrying capacity of wires. The table of capacity recommended by the English Board of Trade and recommended by the N. E. L. A. allowed a rise in temperature of 10° to 12° C. The table of capacity of wires in use by the N. B. F. U. allows a rise in temperature of from 25° to 50° F., and questioned whether this is not too near the safe limit.

MR. MERRILL, in speaking for the N. B. F. U., said that many contractors had complained that the limit was much too low, and that by increasing the amount of current that may be carried they could get a class of work they could not get without it. The table had been compiled hastily, but actual tests had shown them that the carrying capacity given was safe. It had been a matter of experiment, not theory, with them, and they were well satisfied with the results.

MR. JONES said that the trouble with making the carrying capacity of wires too high was the trouble of making people stick to the limit originally intended for the wires. In case of an office building, for example, an outlet that was originally intended for five lights will often have extra lights or fan motors plugged in by the building electrician without consulting anybody, with the result that many circuits are loaded up to double their original capacity. Inspectors cannot be expected to see all these things, and for that reason the limit of carrying capacity of wires should be low.

MR. GREENE said that in some experiments made by the General Electric Company a No. 00 wire was loaded up to 240 amperes, which is only 20 amperes higher than that allowed in the table, and that the wire got warm enough to soften the rubber. The opinion was that the present table of the N. B. F. U. is too near the safe limit.

MR. KENNELLY was appointed a committee of one to take this subject under consideration, and report to the committee on rules at some future time.

The question was discussed as to whether bus bars should be large. Many widely divergent opinions were brought out, but there was a general agreement that the distance between bus bars and terminals should correspond to the potential used. Referred to the committee.

The question as to whether the dynamo frame should be insulated or grounded provoked a lively discussion. Mr. Scott thought that in alternating plants, insulating the frame was useless and that the static charge might be a source of danger to the attendant from touching the frame, whereas a grounded frame would be a factor of safety. Also that many dynamos carefully insulated at the base were connected to the engine by wire-woven belts. Captain Brophy agreed with Mr. Scott. Professor Crocker said that the static charge can easily be taken care of by grounding through a very high resistance or a wet string or a vacuum tube which would take care of the static charge, but leave the dynamo insulated. The attendant should always be protected by an insulated flooring or platform so that he could not possibly be grounded while handling the machine.

Next came the question as to what was high and what low potential. Professor Crocker said that, as in some cases, 200-volt lamps were being used and asked whether under this rule a three-wire system carrying 400 volts between outside wires would be excluded and treated as a high potential system. He thought the limit as to low potential circuits could be just as well raised to 425 volts.

MR. MERRILL said that his association would object at the present time.

CAPT. BROPHY said the Western Union and several other companies used high voltage and he found it necessary to distinguish between them and companies using heavy currents.

MR. JONES said that in telegraph work potentials varying from 400 volts down were used, but of course the currents were small.

The question of substituting plain iron pipe for the iron-armored conduit now in use awakened the keenest interest. So far as heard from every one present favored the use of plain iron, if they could be convinced that burrs and fins in the pipe would not strip the insulation.

MR. AYER favored allowing the use of two wires in a plain iron pipe.

MR. STONE wanted to know whether the lesser expense would justify making the change.

CAPT. BROPHY said that with insulated conduit the insulation on the wires was apt to be reduced to the lowest possible limit. He favored plain pipe with insulation on the wires.

MR. FITZGERALD saw no objection to plain iron pipe and

said that brass-armored conduit had not fulfilled all expectations. This view was also expressed by others.

MR. JENKS cited the case of fixtures wired ten or twelve years ago with the inferior wires then in use which had never made any trouble, which would seem to show that trouble was not necessarily caused by contact with the metal.

MR. SMITH stated that his company (the N. Y. Edison Illunating Co.) had had very little trouble with wiring done in the old days. The case was cited of large uptown flats wired with underwriters' wire pulled into zinc tubes, such as bell wiremen sometimes use; and while the plant had been installed twelve years, only two or three outlets had made trouble.

MR. KENNELLY could see no use in taking such pains with pipe inside of a building.

PROFESSOR CROCKER thought plain pipe good enough, and that whenever they demanded a pipe with a smooth interior they would get it as they got underground conductors when they had to have them.

MR. MERRILL, while not rising to oppose plain iron pipe, wanted to remind the members of one thing that came up in discussing fixtures. Because work improperly done had gone along for years without trouble, it was no reason for allowing such work generally. Statistics gathered by his association showed that the weak point in wiring systems was apt to be the fixtures.

The question of fuses and cut-outs was discussed pro and con.

MR. M'DEVITT thought that fusible devices were all wrong, and that fuses are not reliable by 100 or 150 per cent.

CAPT. BROPHY thought the ordinary run of fuse blocks a delusion and a snare. Many cut-out terminals are too close together.

MR. AYER opposed referring this matter to a committee as practical men were trying hard to solve this problem.

MR. M'DEVITT thought the question of circuit-breakers should be considered in this connection.

CAPT. BROPHY thought the ordinary run of fuse blocks were not always to be relied upon.

MR. GREENE said that the fuse had been unjustly condemned because the time element had not been considerd; and he referred to some tests showing that the wire can be depended upon to carry more current than the fuse, and that where the fuse does not melt the wire is in no great danger of overheating. Supposing a fuse would not go for five or ten minutes, the wire would not get dangerously hot in that time.

MR. M'DEVITT remarked that even if the wire itself was not destroyed, the insulation might become charred, which would be equally objectionable.

MR. JONES thought some method should be arranged so that a 20-ampere fuse, for example, could not be inserted in a 10-ampere fuse block, and that blocks should be proportioned to the circuits they are intended to protect. He also raised the question as to whether resonance affected fuses.

MR. KENNELLY said that resonance never gave any trouble.

MR. SCOTT—Reference had been made to fuses in the Niagara circuits. There was a wide difference between those and ordinary work. Fuses on these circuits are made very sensitive and blow very quickly. They have had very little trouble at Niagara. In one or two instances has a fuse blown out. A fuse should be marked at the amount of current it is expected to carry, also the current at which it melts. They sometimes find that fuses get hot and melt from loose binding screws. In one case a fuse which melted quite often was located in a boiler room, where the temperature was very high and a very slight rise in temperature was sufficient to melt it. When they buy fuses marked 3, 5, or 10 amperes it simply means little, because they probably don't use the same length or surround it by the same temperature as that in which the test was made.

The question of switches was next discussed and referred to the committee.

The question as to whether the ends of the cord in drop cord pendants should be dipped in solder, or whether the inside of the socket cover should be lined with insulating material was discussed and referred to committee.

A question was raised by Mr. French as to the advisability of doing away with ceiling rosettes. Referred.

MR. KENNELLY thought that the secondary coils of a transformer should be grounded at its center to prevent personal injury and to cut out that circuit in case of trouble.

MR. JONES thought that grounding the secondary would put an additional strain upon the insulation between the primary and secondary coils, which in case of lightning would destroy the transformer.

MR. AYER opposed referring this matter to a committee, as systems grounding the secondary would cause a great deal of trouble. He spoke of an automatic device of high resistance which he had used in his own house which was connected to the primary and secondary in such a way as to open the former in case of any connection between the two coils.

The English and Phoenix rules on this subject were read and discussed at length and the whole subject was finally referred to a committee.

The subject of car wiring brought Mr. Ford up with the remark that this subject had been slighted and not given the attention it deserved. He also thought that under proper restrictions lights and motors might be taken from trolley lines in places where no other electric power was available.

MR. MERRILL asked what restrictions he would have, and then went on to relate that one set of regulations that he had seen demanded that a circuit-breaker, a fuse cut-out, an automatic breaker, and handswitch also be placed in the circuits; that the building in which the motors or lights were located should be practically isolated and the return wire should be carried back to the power station. Under all these restrictions he thought it would be beter to install an isolated plant and under all the circumstances that it would be better to prohibit such work altogether.

MR. AYER called the attention of the committee to electric car heaters and also said that only flexible conductors should be used in car wiring.

When the conference came to the list of wires recommended by the N. B. F. U. the general opinion seemed to be that it should be stricken out and specifications showing clearly the kind of wire desired substituted.

In reading the rule upon the subject of tests (Rule 46) Mr. Kennelly raised the question as to what these tests were based upon. Thus 10 amperes requires an insulation of 4 megohms, or 40,000,000 ohms per ampere, 200 amperes requires 160,000 ohms, or 32,000,000 ohms per ampere, while a current of 1,600 amperes requires only 11,000 ohms, or 17,600,000 ohms per ampere. Of course switches and connections will make some difference, but should it be so much?

It seems that the Boston rule for underground conductors of 20 megohms per mile for each 100 volts is a good one, as it furnishes a definite standard.

This practically ended the discussion on rules, and after a discussion of the question of the adoption of by-laws at the present meeting, the question was laid over.

The thanks of the conference were extended to the N. E. L. A. for their efforts in behalf of the meeting. Also to Mr. Hammer, the presiding officer. Also to the American Society of Mechanical Engineers, for their courtesy in tendering the use of their building as headquarters for the committee. Conference adjourned to meet June 25-26, or sooner, at the call of the chair.

LEGAL NOTES.

THE COMMON CARRIER QUESTION IN TELEPHONY.—AN ADVERSE DECISION.

An important decision was announced by Judge R. G. Siebecker, of the Wisconsin Circuit Court, at Madison on March 18, in the case of the Dane County Telephone Company against the Western Union Telegraph Company. He notified the attorneys he had decided to deny the writs of mandamus asked by the telephone company to compel the Western Union to admit new telephones to its offices.

The question involved was a new one, with no decision of other courts on the point at issue. Judge Siebecker has not filed his opinion in the case, but has formally notified the attorneys of his decision. There is no doubt that the case will be taken to the Supreme Court for a final decision.

Judge Siebecker's decision, as announced to the attorneys, is as follows: "In this case I have found no decision nor has one been cited to me controlling the matter. Upon the principle as to the duties of common carriers I found no adjudication covering the question here at issue. I have come to the conclusion that the application differs radically from the principles determined in cases cited, wherein one common carrier has been compelled to offer the same rights and privileges to the public that it has by means of its relationship to another common carrier.

"To grant the application the court would have to say that the transmission of telephonic messages and the delivery thereof from the office of the telegraph company over the wires of the telephone company is a public right that can be enforced as such, against telegraph companies by reason of its being a common carrier. I think that this principle cannot be applied, for the reason that the telegraph company may deliver its messages or receive messages upon its own terms and stipulations, as long as they are reasonable. The fact that this telegraph company does so for the telephone system of the Bell Telephone Company is a personal privilege or right they may exercise as they may see fit. For these reasons the application must be denied."

Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

THE THOMSON INCLINED COIL PORTABLE ALTERNATING CURRENT INSTRUMENTS.

IN the matter of portable instruments for alternating current work, the practical electrician has, heretofore, been compelled to choose between the high grade, high-priced instrument and the low-priced and usually unreliable one. Reliable portable instruments at reasonable prices have been lacking, and, as a consequence, the demand for them has become both crying and extensive. Realizing this fact, the General Electric Company has undertaken to meet this demand by placing upon the market a complete line of ammeters, voltmeters and indicating wattmeters.

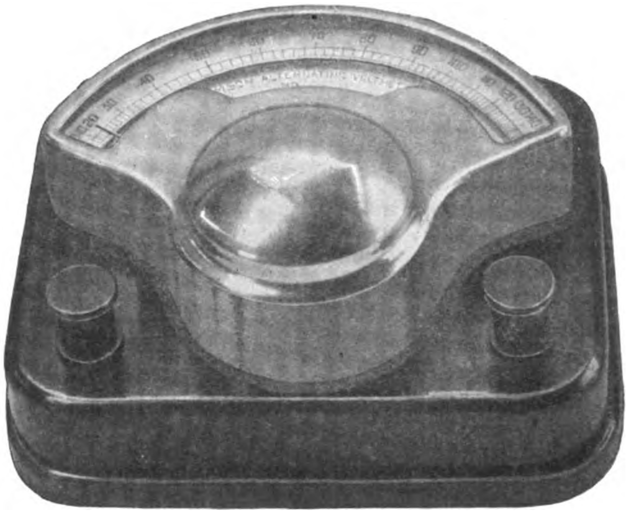


FIG. 1.—THOMSON INCLINED COIL ALTERNATING CURRENT VOLTMETER.

These devices developed by Prof. Elihu Thomson himself embody all the improvements which knowledge of every requirement and long experience suggest. They are compact in form and accurate, and may be used on all alternating current circuits, whatever the frequency and whatever the wave form. No parts liable to change enter into their construction, and accuracy, consequently, is insured for an indefinite period. These instruments are of the series type. The difficulties inherent in shunt instruments are thus absent. They are dead beat, a depressible button operating an attachment by which the needle is immediately brought to rest without detracting from the sensitiveness of the instrument.

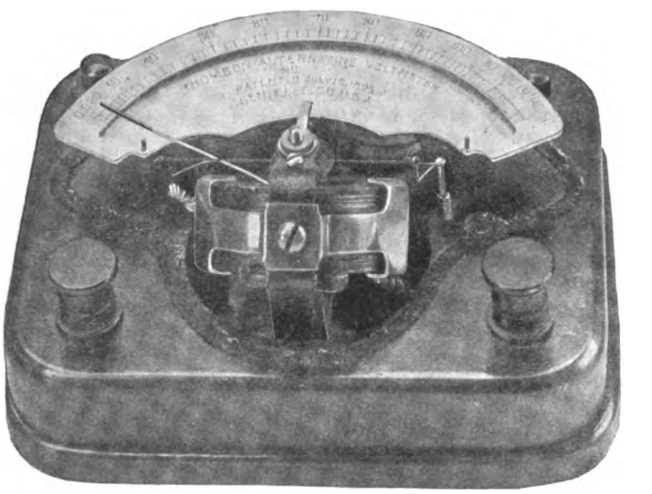


FIG. 2.—THOMSON INCLINED COIL ALTERNATING CURRENT VOLTMETER.

The voltmeters, illustrated in Figs. 1 and 2, are standard for alternating current work, but may be used with good results on direct current circuits in cases where the highest accuracy is not required. The indicating wattmeters give accurate readings with angles of lag on all inductive loads met with in commercial practice. A special field will be found for these in central station practice, testing and calibrating recording meters, testing transformers and measuring their efficiency, in testing the energy consumed in alternating current arc lamps and incandescent lamps, small fan and other motors, etc.

With the indicating wattmeter, shown in Fig. 3, accurate measurements on direct current circuits may also be obtained, provided two observations for each reading are taken with the instrument connections reversed between the readings—the mean of the two readings giving the correct result. Upon each wattmeter the maximum current at which it may be used is marked. They indicate accurately on any potential from 0 to 150 volts.

FIG. 3.—THOMSON INDICATING WATT-METER.

The range of sizes of these instruments is such as to meet all and any requirements. The ammeter is made in the following quantities: 2, 10, 25, 50, 100 and 200 amperes, the voltmeter for 75 and 150 volts, and the indicating wattmeter for 100, 300, 1,500 and 2,500 watts, that for 100 watts having been especially designed for measuring iron losses in transformers and for testing incandescent lamps. The scales are exceptionally long and clear.

In appearance and workmanship the instruments may be favorably compared with the most costly on the market. They are both neat and handsome, having bases of mahogany and covers of polished nickel. Each instrument is packed in a hardwood carrying case. These instruments are known as the Thomson Inclined Coil Portable Alternating Current Instruments, and the principles of construction can be gathered from the illustrations.

THE EDDY ELEC. MFG CO. IN THE WEST.

An important arrangement has just been effected by the Eddy Electric Manufacturing Company, of Windsor, Conn., with Mr. G. W. Russell, Jr., of the Russell Electric Company, of Denver, Colo., by which that gentleman becomes their representative for the district comprising Colorado, Wyoming and Utah. While this region is not thickly settled, it is one where the mining wealth is enormous, and where questions of power transmission assume considerable magnitude. The Eddy generators and motors are already very favorably known in the electric mining field, and Mr. Russell's large experience and acquaintance will prove of great value in his new connection, upon which both parties are to be congratulated.

HOW WOVEN WIRE BRUSHES WEAR.

Mr. W. H. Fleming, 393 Pearl street, New York, has received the following from Mr. D. Howe, electrician for Reed & Barton, the silversmiths, of Taunton, Mass.:

Yours in regard to Woven Wire Dynamo Brushes of the 6th was duly received. On investigation I find that the wear of brushes on three machines in use from one to two years averages about half an inch yearly. As these brushes were five and seven inches long when put on, I shall not need new ones for a long time. With commutator in proper condition, brushes correctly adjusted, the wear is hardly noticeable.

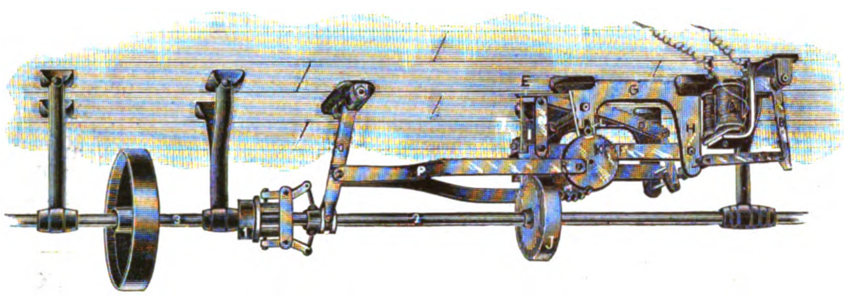
THE STANNARD ELECTRIC CLUTCH.

THE accompanying engraving shows a new electric controller for friction clutches, patented by J. E. Stannard, of 48 Lebanon street, Springfield, Mass. This is designed to controll friction clutches on main lines of shafting, both in stopping and starting, and in case of accident will release the clutch in two to three revolutions, thus preventing serious accidents.

The controller is usually placed overhead, near the clutch, as shown, and takes its power from the driven section of the shaft by means of the friction pulley shown, and is powerful enough to work any size of clutch. In large mills it is designed that each section or floor can be stopped independently of any other, and will only delay the section where it is necessary to stop.

Electric wires are run to all points desired and switches placed where convenient. To stop, it is only necessary to push the switch, which will instantly bring the frictions together and instantly release the clutch from the driving power, and lock it out. As long as the person that worked the switch keeps it out of connection, it is impossible for any other person to start the shaft by any other switch, so that no accident can occur from that source. When ready to start the shaft again, the switch is pushed and the frictions again come in contact, and push the clutch into working position, but at a very much slower speed, so as not to strain or jar the clutch or machinery. This gives full control of shaft for both starting and stopping, and can be placed at any distance, as, for instance, in another building. It will be found a great convenience aside from the safety derived from its use in case of accident, for which it was especially designed.

This controller has been in practical use for the past year and has been found reliable and in one case at least has prevented serious accident. A 50-horse-power clutch occupies a space of 14 x 30 inches over the shaft.



THE STANNARD ELECTRIC CLUTCH.

WATERTOWN ENGINE SALES.

The Watertown Engine Company report the following sales for February:

Clarkson Institute Technology, Potsdam, N. Y., two 50-h. p. vertical direct connected (2d order).

Philadelphia "Evening Telegram," Philadelphia, Pa., two 50-h. p. high speed, direct connected.

Keystone Lime and Stone Company, Tyrone, Pa., one 70-h. p. Excelsior (3d order).

Broadway Central Hotel, New York City, one 70-h. p. high speed, (2d order).

L. Z. Bach, New York City, one 70-h. p. high speed, direct connected.

J. Monroe Taylor Building, New York City, one 50-h. p high speed.

Wissahoming Apartment House, New York City, one 70-h. p. high-speed, direct connected.

Gillespie Apartment House, New York City, one 70-h. p. high speed, direct connected.

Augustus Noll, New York City, one 70-h. p. high speed, (2d order).

New York Electric Equipment Company, New York City, one 100-h. p. high speed.

Wolcott Electric Light Company, Wolcott, N. Y., one 60-h. p. high speed.

C. H. Angus, Albany, N. Y., one 50-h. p. slow speed.

C. R. Remington & Son, Watertown, N. Y., one 50-h. p. Excelsior, (5th order).

J. B. Wise, Watertown, N. Y., one 125-h. p. slow speed.

New Orleans "City Item," New Orleans, La., one 40-h. p. high speed.

Nashua Manufacturing Company, Nashua, N. H., one 75-h. p. slow speed.

Hathorn Fancy Forge Company, Bangor, Me., one 50-h. p. slow speed.

G. R. Andrews, Northfield, Conn., one 75-h. p. Excelsior.

Pacific Lounge and Mattress Company, Tacoma, Wash., one 75-h. p. Excelsior (2d order).

Hydraulic Placer Syndicate, Lewiston, Idaho, one 40-h. p. Excelsior.

Lindell Hotel, St. Louis, Mo., two 75-h. p. Excelsior.

POWERFUL FLUORESCENT SALTS FOR ROENTGEN RAY EXPERIMENTS.

The discovery, which Mr. Edison announces in another column, of a salt which fluoresces far more strongly, under the influence of Röntgen rays than barium platino cyanide, which has heretofore been considered the most efficient salt for the purpose, promises to be of very great importance to all who are investigating the phenomena attending the electric discharge through vacuum tubes.

With this salt properly applied to a suitable screen, the fluorescence is found to be six times as intense as with barium platino cyanide under the same conditions; this, of course, greatly facilitates the work of investigation, and makes it possible to see, at once, results which with the slow and uncertain photographic plate, sometimes require hours to determine.

It is remarkable that, while the effects of the Röntgen rays and their peculiarities have been studied so widely during the past few weeks by means of the photographic plate, so little had been done in simplifying the means for making these investigations. Mr. Edison's very complete tests have made it certain that many substances ordinarily found in the chemist's laboratory exhibit this property of fluorescing under the influence of the X-rays; several substances were found which were more strongly fluorescent than barium platino cyanide, but one of the tungstates of calcium was found to be several times more efficient for this purpose than any of the others.

The theory that it is only the heavier substances which possess this property of fluorescence does not hold good on investigation; one of the light organic salts, salicylate of ammonium, was found to possess it to a remarkable degree. It is found that only a few of the many calcium tungstates fluoresce under the influence of the X-rays; the particular modification which gives the greatest fluorescence without retaining a phosphorescent glow is produced only by skillful chemical manipulation. Mr. Edison is not manufacturing the tungstate himself, but, under his directions, Messrs. Aylsworth & Jackson, of Orange, N. J., have put on the market a "fluoroscope" containing the fluorescent salt prepared ready for use.

AT THE BERLIN IRON BRIDGE WORKS.

The Berlin Iron Bridge Company, of East Berlin, Conn., are very full of work and are running their entire plant with a full force of men. They report contracts lately completed as follows: New casting shop and machine shop for Randolph & Clowes, Waterbury, Conn.; new car house, engine room and boiler house for the Bergen County Traction Company, at Fort Lee, N. J.; a new steel tube plant, including power house, accumulator house, coal storage, etc., for the Pope Manufacturing Company, of Hartford, Conn.; two bridges for the American Sugar Refining Company, at New Orleans, La.; new power house and boiler plant for the Hackensack Gas and Electric Company ,at Hackensack, N. J.; a large foundry for the Bagley & Sewall Company, at Watertown, N. Y.; a large machine shop for the Granger Foundry and Machine Company, at Providence, R. I.; an iron bridge, consisting of five spans of 200 feet for Penobscot County, Me.; a new carshed building for the

Third Avenue Railway Company, at Harlem River, N. Y.; three large buildings for the Standard Oil Company, at Constable Hook, N. J.; a new forge shop for Pratt & Whitney Company, at Hartford, Conn.; a new storage house for Bradley & Hubbard, Meriden, Conn.; a new tube plant for the Coe Brass Manufacturing Company, at Torrington, Conn.; a large extension to a producer house for the Solvay Process Company, at Syracuse, N. Y.

P. & B. THE WORLD OVER.

The Standard Paint Company's products are gradually but surely gaining a foothold wherever civilized man is settled, and Mr. R. W. Shainwald's recent trip abroad has resulted in the establishing of a number of agencies in European countries, through which the company's products can be secured direct. We have before us a circular done in choice Dutch, extolling the virtues of the various P. & B. compounds, and materials, which ought to prove convincing to our friends in the Low Countries. The Holland P. & B. agency is located at Hendrikkade, 21, Amsterdam.

A SAMPLE CARD OF MICANITE INSULATION.

The Mica Insulator Company, sole manufacturers of "Micanite," 218 Water street, New York, with factories at Schenectady, N. Y., and London, England, are sending to the trade a large sample card, handsomely got up, showing samples of Micanite commutator segments, rings, and slot insulation, for standard railway motors and power generators. Micanite and Empire insulating cloth and paper are shown in nine different grades, which are used largely for insulating armature cores and fields. In circular form, at the top of the card, appears the name of the company, and printed in red is the trade-mark, "Micanite, Perfect Insulator," at the right of which is the statement that manufacturers of electric light and power machinery have adopted Micanite as the standard insulator, and that estimates will be cheerfully given on insulation for special designed machinery when sketch or blue prints are furnished. The lower part of the card is given up to the list of agencies in the principal cities who carry a stock: Chicago, W. H. Sills & Co.; St. Louis, A. S. Partridge; Cincinnati, Sinclair Randall; Cleveland, the Cuyahoga Supply Company; San Francisco, J. W. Brooks & Co.

On the back of the card appears a description of the different lines of insulation that the company manufactures. This card has been gotten up at considerable expense, and has been sent to all manufacturers of electrical machinery, electric repair companies, and street railways in the United States, and is highly appreciated. The company is enjoying an excellent trade on their Micanite, which has become known as a standard insulation, both in this country and in Europe.

RICE & SARGENT ENGINES FOR THE BOSTON WEST END.

The West End Street Railway Company, of Boston, Mass., operating the largest street railway system under one management in the world, and using engines of various makes aggregating 20,000 horse-power, have contracted with the Rice & Sargent Engine Company for two cross-compound engines, to be direct-connected to electric generators.

These engines were selected in competition with the leading engine builders of the country, and their general dimensions are as follows:

Indicated horse-power, each engine		1,500
Diameter of high-pressure cylinders	inches	26
Diameter of low-pressure cylinders,	"	50
Length of stroke	"	60
Number of revolutions per minute		80
Steam pressure per square inch	lbs.	150
Diameter of flywheels	feet	24
Weight of flywheels	lbs.	120,000
Diameter of shaft in wheels	inches	24
Diameter and length of main bearings	"	22 x 38

The rims of the flywheels will be composed of forged steel, according to a new design, originating with the Rice & Sargent Engine Company, and the wheels will be practically indestructible.

Jet condensers and air pumps, driven by independent engines, will be used. Reheating receivers will be placed between the cylinders, and the piping will be arranged so that either cylinder of either engine may be run alone if desired.

The design is an unusually massive one, even for street railway work, which is responsible for much of the increase in weight of modern engines.

THE MANUFACTURERS' ADVERTISING BUREAU.

The Manufacturers' Advertising Bureau, Benj. R. Western, Proprietor, which has been located for a number of years at 111 Liberty street, New York City, will remove about April 15 to more commodious quarters at 126 Liberty street. This concern is widely and favorably known throughout both this country and abroad. It takes entire charge of the newspaper work and advertising for manufacturers, who desire to have this very important department of their business conducted with the greatest convenience and profit, free from personal worry. The bureau handles almost exclusively concerns who advertise in the trade journals, Mr. Western being a recognized expert in advertising media of this character, and has established a reputation for commercial integrity and scrupulous attention to the interests of its clients, of which it may well feel proud. A large number of the leading machinery concerns in the country entrust their advertising to the care of this institution. It is because of a growing need for better facilities to transact its business that the change from 111 to 126 will be made.

COOK-STODDARD MFG CO.

The Cook-Stoddard Mfg. Co., makers of gas and gasoline engines, have recently added to their factory at Dayton, O., a department for the manufacture of electrical machinery. They will build electric generators and motors of all sizes. Mr. Shawhan, formerly of the Shawhan & Thresher Electric Co., is connected with them, and will have charge of the work in this new and important department. The company propose to turn out the best apparatus, and will be glad to quote on orders.

WESTERN NOTES.

THE SOUTHERN ELECTRICAL SUPPLY COMPANY, of St. Louis, have recently removed from their old address at 11 North Seventh street, to new quarters at 10, 12 and 14 South Seventh street, where they have opened a very handsome store, which is stocked with a fine variety of electrical supplies, including the well-known Okonite wires and cables, interior conduit specialties, and Lundell motors. Mr. C. E. Sharpe manages the business of this company, and deserves to be congratulated upon the successful manner in which he attends to the welfare and improvement of the concern.

THE ELECTRIC APPLIANCE COMPANY has been fortunate in securing some nice contracts for bare copper wire, acting as Western selling agents for the Taunton Copper Manufacturing Company. The product of this mill is well known as a particularly high grade article, and the Electric Appliance Company hope to make it one of their leading specialties.

ADVERTISERS' HINTS.

KENNEDY & DU PEROW, Washington, D. C., are now agents for the Kerite wires and cables.

THE WESTINGHOUSE MACHINE COMPANY offer some interesting information regarding their inspection department. The conditions there prevailing are most exacting in every detail and should suffice as a guarantee of thorough workmanship and first-class material.

THE WATERTOWN STEAM ENGINE COMPANY are now represented in New York, Boston, and Philadelphia. Any communication to any of these offices will receive prompt and careful attention.

THE ELECTRIC APPLIANCE COMPANY are selling from a complete stock of incandescent lighting supplies, as well as all the latest novelties and staples in the supply line.

THE INTERIOR CONDUIT AND INSULATION COMPANY, in a letter to the trade, offer some suggestions well worthy the consideration of central station men.

THE MICA INSULATOR COMPANY briefly describe the De Ferranti alternator at Deptford, England, and it plainly shows how important a part Micanite forms in the construction of a dynamo.

ALEXANDRIA, IND.—The Stillwell-Bierce and Smith-Vaile Company of Dayton, O., have installed a plant for the water-works system of this city, comprising two duplicate pumping engines, each of 2,000,000 gallons capacity every twenty-four hours. The plant is also equipped with the Stillwell heater, filter and lime extractor. The official tests have, as usual, proved very satisfactory.

Department News Items will be found in advertising pages.

THE
Electrical Engineer.

Vol. XXI. APRIL 1, 1896. No. 413.

Electric Transportation.

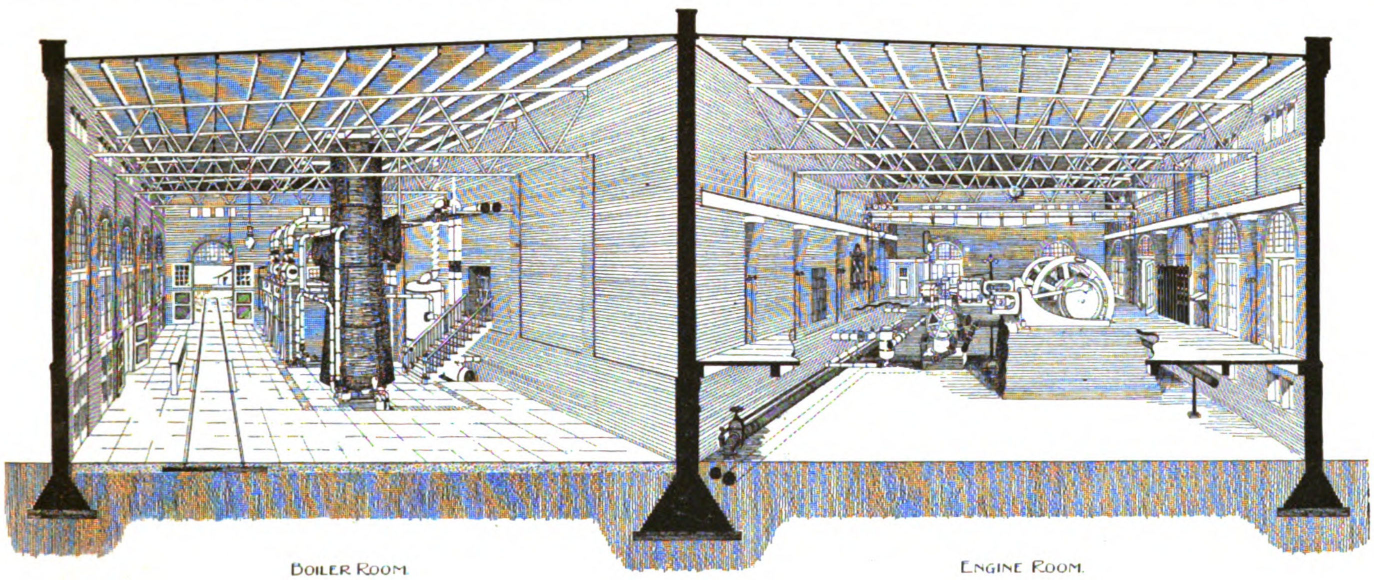
THE ELECTRICAL EQUIPMENT OF THE ORLEANS RAILROAD, NEW ORLEANS, LA.

THE Orleans Railroad was organized in 1867 at the beginning of the political reconstruction period in the South. It stands as one of the first of the industrial undertakings which have, in the last thirty years, accomplished so much in the development of the natural resources of Louisiana. This road has been owned and operated from the beginning by French-Americans, or Creoles. All of its lines extend entirely through the north side of New Orleans, or what was the old French city, and it touches at many of its most interesting and profitable traffic points. Owing to the narrow streets (which average about twenty-three feet from curb to curb) almost the entire line is laid out in single track. The illustrations in this article show some of the streets occupied.

Among the distinguishing features of the road may be mentioned the terminus and stand at Clay Statue, which is the business center of the city and by far the best traffic point possessed by any railway company in New Orleans. Other terminal points are the quaint and picturesque old French market, situated on the Mississippi River, the fair grounds at Sauvage street, the City Park, and the Metairie cemeteries. The fair grounds contain an exceptionally fine race track, on which, during 100 days of the winter season, the Crescent City Jockey Club conducts the series of races so well known in all sections of the country.

The Orleans Railroad Company adopted electric traction in order to compete successfully with other roads recently equipped. Until submitted to this unequal comparison, it had paid substantial dividends for a number of years. After a conservative discussion, the stockholders appointed a construction committee, consulting engineers were engaged, and bonds were issued to provide funds for the work. Since then the construction has been accomplished in the most expeditious manner. A statement of the method employed in the building of this road is interesting, because typical of the most approved method of recent engineering practice. Plans and specifications were prepared by the engineers, bids obtained from the best contractors in each line, and contracts let upon each item. Each contract had its accompanying plans and specifications, and the work was constantly under critical inspection and supervision by the engineers. The contracts were carefully drawn so as to be mutually exclusive, but together forming the complete construction. In this way, the contractor upon each particular part of the construction was a specialist in that line, so that the resulting work was done to the best possible advantage and the middleman's profit of a general or "bulk" contractor was saved to the company. Material and equipment were purchased at the lowest ebb of panic prices, and it is doubtful if there is a road more cheaply equipped for the same grade of material than this one.

A list of the contracts necessary for the complete equipment of this railway follows. With the exception of a few special features peculiar to New Orleans, this list includes all the items necessary for first-class electric railway construction:



SECTIONAL PERSPECTIVE OF BOILER AND DYNAMO ROOM, ORLEANS RAILROAD CO.'S POWER HOUSE.

Contracts for the Electrical Equipment of a Horse Railway.

Preliminary—

Real estate for power house 1
Removal of old buildings on this site 2
Water supply, driving artesian well 3

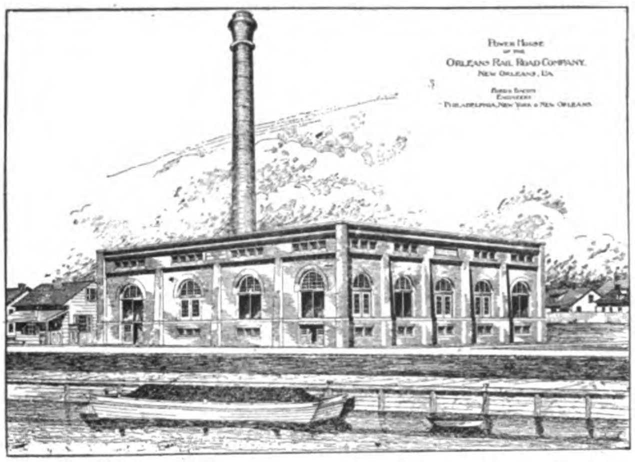
Power House—

Steel trusses and roof framing erected 4
Masonry, brickwork, carpentry and finish entering into foundations and building proper 5
Foundations for stack, boilers, engines, generators, condensers, pumps and piping 6
Boiler setting and stack lining 7

Power Machinery—

Self-supporting steel stack, flue and breeching, erected 8

Boilers erected 9
Engines erected 10
Generators and switchboard erected and connected........11
Air pumps and condensers erected 12
Feed pumps, delivered 13
Feed water heater, delivered 14
Complete steam, water, drip and blow-off piping, erected, including separators, oil purifier, gauges and gauge boards, valves, pipe covering, fire apparatus, erection of feed pumps and heater, and painting of all machinery......15
Traveling crane and track erected 16
Coal-handling apparatus 17
Arc lamps, fixtures and lighting wiring....................18



Power-House of the Orleans Railroad Co., New Orleans. View from River.

Car Equipment—
Trucks, delivered at car factory 19
Motor equipments, mounted at car factory 20
Car bodies, complete with fenders, registers, etc., delivered with motor equipments and trucks 21
Tower wagon, delivered 22

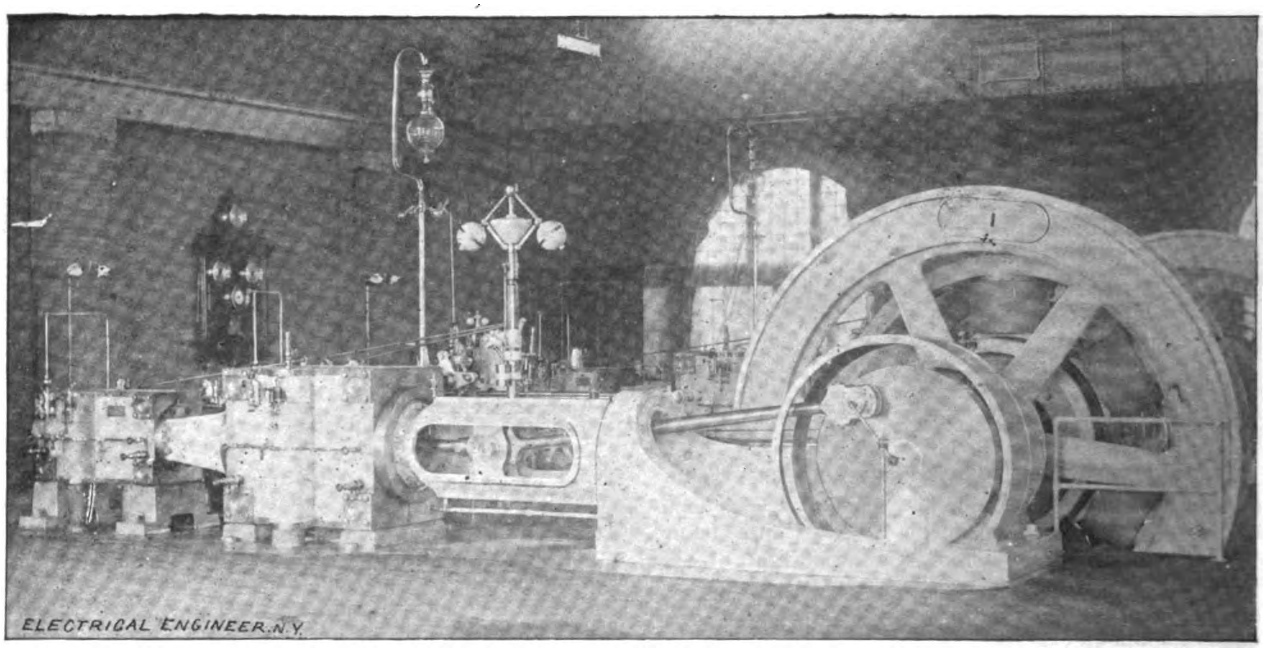
The names of the principal contractors were as follows:

Contract No. 4, roof trusses, contractor, Gillette-Herzog Co.
Nos. 5, 6, 7, 23, building and foundations, Chas. Garvey.
No. 8, stack and flues, Lewis Metesser.
No. 9, boilers, Heine Safety Boiler Company.
Nos. 10 and 12, engines and condensers, E. P. Allis Company.
Nos. 11 and 20, generators and motors, General Electric Co.
Nos. 13 and 14, feed pumps and heater, Smith-Vaile Co.
No. 15, piping, Benj. F. Shaw Co.
No. 16, crane, Brown Hoisting Co.
Nos. 18 and 27, overhead line and wiring, Creaghead Engineering Co.
No. 19, trucks, Baltimore Car Wheel Co.
No. 21, car bodies, J. B. Brill Co.
No. 25, rails and special work, the Johnson Co.
No. 26, track construction and paving, C. E. Loss & Co., and C. B. Fisher.

Power Plant.—The power plant is situated on the Carondelet Canal, or Old Basin, convenient for coal and condensing water and central to the feeder system. The location of the building upon the lot is such as to provide a driveway all around it with space for rear extension. The building design secures an ample supply of air and light without the objectionable features of a monitor roof construction. The absence of snow renders a flat roof most desirable for Southern climates. Large doorways sixteen feet in height open the three outer walls of the boiler room to ventilation and light. Broad casement windows secure the same advantage for the engine room. The engine and boiler rooms are each 48 feet by 82 feet interior dimensions. An eight-foot basement under the engine room provides space for separators, receivers, condensers, piping, and foundations. The front and sides of building and the engine room interior are faced with salmon-colored pressed brick. The trimmings are in limestone. A Fletcher roofing is applied to matched pine roof boards. Steel trusses and framing support the roof boards. The engine room floor is of mill construction. The boiler room floor is Schillinger pavement on eight-inch concrete foundation.

The subsoil consists of a black alluvial clay strewn with cypress stumps. All foundations for buildings and machinery are floated on a cypress plank flooring six inches thick and wide enough to support the load without settling. The walls are battered out to bear on this flooring. Dyckerhoff Portland cement is used in all underground work for concrete and brickwork.

An artesian well furnishes, when pumped, 345,000 gallons



Tandem Compound Condensing Engines in Orleans Railroad Co.'s Power House, New Orleans.

Car House—
Raising roof, renovating horse car barns and building pits..23
Repair shop tools 24

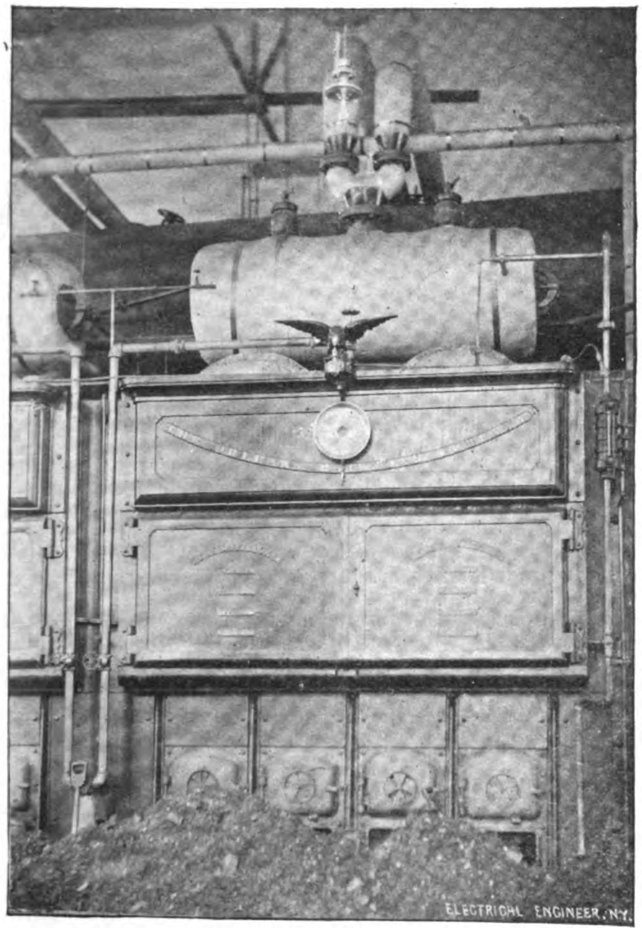
Line Work—
Rail material and special work, delivered 25
Track material, track construction and paving 26
Overhead line material and construction 27

per day. This water is used for condenser injection and feed. It contains a large proportion of carbonates which are precipitated in the open feed water heater.

The boiler room is designed for 1,000-horse-power water tube boilers in two batteries, half of which is at present installed. A self-supporting steel stack with breechings and flue connects to the boilers. The stack foundation is of concrete, 22 feet by

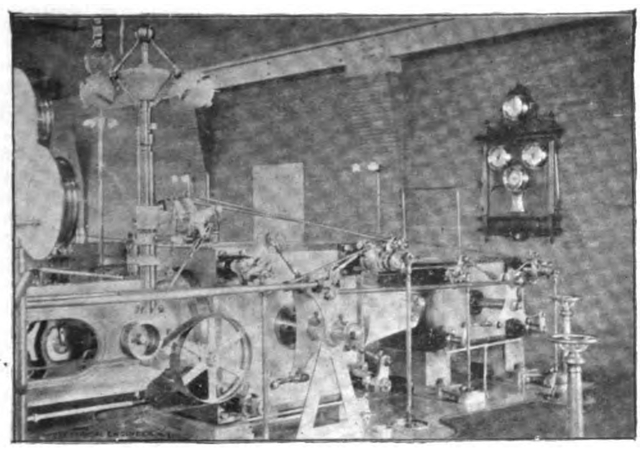
22 feet by 8 feet, entirely below the floor of the boiler room. Where the flue enters the stack a large reinforcing ring is riveted.

The engine plant is designed for 1,200 horse-power of tan-



A Heine Boiler Unit in Orleans Railroad Co.'s Power House.

dem compound condensing Corliss engines in three units, two of 300 horse-power and one of 600 horse-power. The two 14 x 26 x 36 engines now installed are direct connected to 200-kilowatt multipolar generators of the ironclad type. Each machine will run twenty-five single-motor cars, owing to the absence of grades on the line. These engines run at 120 revolutions per minute. The action of the valve gear and dash



Improved Corliss Valve Gear.

pots at this speed is most satisfactory, a result obtained by double porting the valves and lightening the moving parts, as seen from the above illustration. The exhaust valves in the low pressure cylinder are operated by a separate eccentric to admit of a wide range of cut-off.

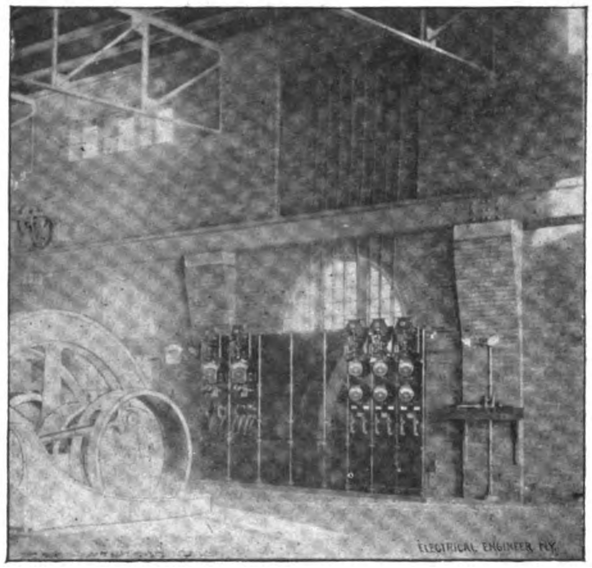
An independent vertical flywheel air pump and condenser are used with each engine. All the main valves of the condenser and engine piping are connected with valve stands in the engine room.

A standard black enamel slate panel switchboard is used with provision for two generators and six separate feeder circuits. Blank panels are installed for future equipment. Weston meters and Carpenter enamel rheostats are used on the board.

Individual gauge boards are provided for each engine, and a main board for the station. Crosby steam gauges are used.

The Davis system of duplicate high pressure steam piping is used. Each of the two mains is of such a size as normally will require the use of both headers and both leaders for any given engine or boilers. In case of necessity, one-half of the system is shut down, and the other half forced during the stoppage. In the usual duplicate systems where one pipe line is always idle, the leakage is generally sufficient to keep the idle main at the temperature of the live steam and makes it a radiating surface. This latter duplicate system therefore contains 43 per cent. more exposed live steam areas than the Davis system. The large duplicate system is also difficult to operate quickly in case of accident, on account of the sticking of valves, and has also the objection of almost prohibitive first cost. All of which difficulties are, it is said, overcome in the smaller system.

The pipe fitting of this plant also includes condensing



The Switchboard, Orleans Railroad.

and exhaust systems, feed water and purifying systems and drip and blow-off systems. Extra heavy wrought iron pipe is used in the live steam system, which is designed for a working pressure of 150 lbs. per square inch. Long radius bends take the place of fittings wherever possible. Copper bends occur where necessary to provide for expansion. Drips from all live steam mains are returned to the boilers. Valves, flanges and fittings in the live steam pipes are of the Chapman high-pressure standard. All joints are flanged with pipe screwed and peaned. The water piping is so arranged that either canal or well water can be used for condensing or feed. The feed is drawn from the hot well of the condenser, passed through the open heater and into the boilers at a temperature of 200° Fahr. A double covering of asbestos and hair-felt is used for all live steam surfaces.

A ten-ton traveling crane with hoist runs the length of the engine room.

The interior finish of this plant has been carefully planned. Engines, generators and air pumps are painted with a white enamel and simple gold striping. The railings, arc light fixtures, gauges, lubricators, etc., are all in nickel. The crane track, crane and trusses are a light straw color. The roof boards are in natural finish, varnished.

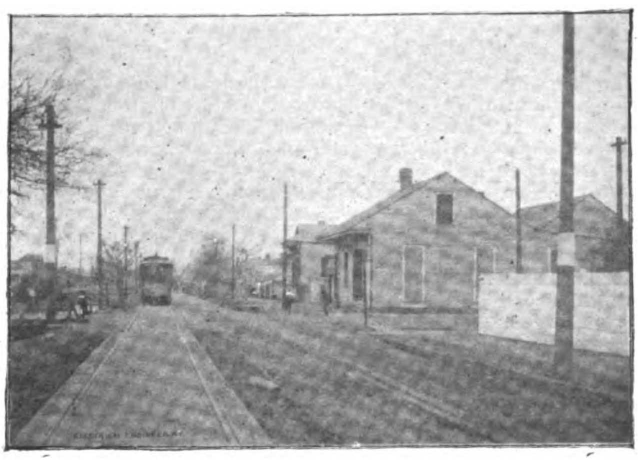
The Orleans power plant is considered by railway authorities to be one of the most efficient and carefully designed stations in the country.

Track Work.—The style of construction is that which has been found best adapted to New Orleans soil, consisting of a layer of one-inch cypress planking, extending over the entire subgrade. Upon the planking is placed four inches of Rosetta

or Bartlett gravel. This gravel has in its composition a sufficient amount of iron ore compounds to make it under pressure a concreting substance. After the track has been placed on 6 x 8 x 8 ties and the gravel thoroughly tamped, six inches of concrete is rammed between ties and between tracks. The paving at the Clay Statue consists of imported Belgian blocks on a two-inch sand cushion and concrete, as previously stated. The interstices between the blocks are filled with Assyrian asphalt. The same substructure continues throughout the work, but the pavement changes according to the location, consisting variously of large square granite blocks, cobble stone and planking. Where square block pavement is used, the rails are placed on five-inch by nine-inch stringers, which rest upon ties, the planking, ties and stringers being of cypress. The ties are placed twenty inches on centers at the joints, and at other points thirty inches on centers. All joints are secured by twelve one-inch bolt joint plates, the joints being suspended. The abutting ends of rails are placed in contact, and the joints are placed exactly opposite. Tie rods are spaced six feet apart throughout. The rails and special work installed on the Orleans road are of nine-inch girder, 90 lbs. per yard, and have proved most satisfactory in every particular. The bonding of the rails is what is known as the triple laced bond with channel pins, and the greatest care was taken to make this perfect.

View Showing Pole and Line Construction on Narrow Streets.

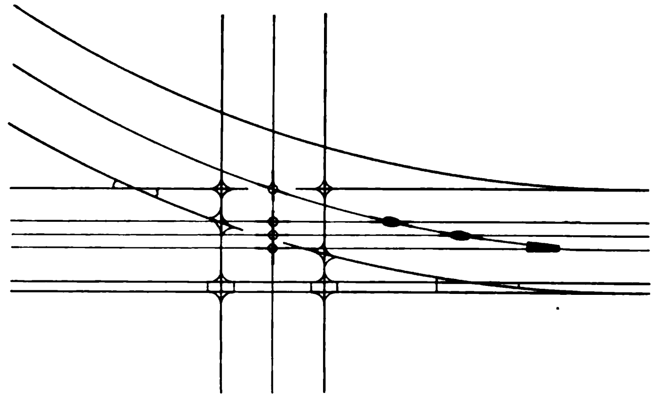
Overhead Line Work.—The permanent and substantial style of overhead construction is shown in the illustrations. It may be said that the greatest variation of pressure over the entire line is about fifty volts.



Plank Road Track in the Outskirts.

On the narrow streets bracket construction as illustrated is used throughout. The hangers are of special design, double insulated with flexible link joints. The section of line construction on Canal street is probably one of the most interesting and complicated in the United States. Canal street is the principal shopping and business center of the city, and the one street upon which all of the street railway companies operate. The total width of the street is 135 feet between curbs. It contains a "neutral ground," or continuous park, from the river front to the new basin. All railway tracks on the street are placed on the neutral ground, and the section between the river and Rampart street is the principal terminus of all the street railway lines of the city. There are in place now five continuous tracks. The three center tracks are used exclusively by the New Orleans Traction Company. The two outside trunk tracks, laid in double gauge, are owned by the Canal and Claiborne Railroad Company, who lease rights to operate at a fixed trackage to the Orleans Railroad Company, to the New Orleans and Carrollton Railroad Company, and to the St. Charles Railroad Company. Each of these companies has its individual trolley wire, and it is due to this and the fact that the New Orleans Traction Company continually crosses the trunk lines that the work becomes so complicated. Our diagram shows the ten trolley wires in position. The distance between trolley wires over the same track is eight inches. The poles are thirty-two feet in length, weigh 1,200 lbs., and are placed ninety feet apart. Bracket construction was used to make the structure reliable. If all wires were placed on a single span, the breakage of one of the spans would disable the entire railway traffic of the city. All line material is of special design. More than fifty specially designed insulated crossings are now being erected. All the poles are set in Dyckerhoff cement concrete in proportions of 1, 2, and 3. This work was designed and erected under the superintendence of Ford & Bacon, for the Orleans Railroad Company, the Canal and Claiborne Railroad Company, and the New Orleans and Carrollton Railroad Company. The New Orleans Traction Company and the St. Charles Railroad Company also use this overhead structure.

Car Equipment.—During the present summer and fall the road will operate from twenty-five to thirty cars over their present tracks and extensions. The Brill cars have 18-foot and 20-foot bodies. The interior finish is in natural ash and holly wood, obtaining a cool and light effect. The lighting consists of eleven lamps, two on platform, three in monitor roof and three on each side of the car at the upper window line between the windows. This has helped materially to make the cars popular, as one can read in any position. The equipments are of single G. E. 800 motors. All seats are of the Hale & Kilburn spring rattan pattern.



Overhead Line Construction on "Neutral Ground."

The officers of the company are: P. Cougot, President; James Pollock, Secretary, and H. J. Malochée, Superintendent. Plans and specifications for the entire construction and equipment were furnished by Ford & Bacon, engineers, of New York. Philadelphia and New Orleans, under whose superintendence the various contracts were executed.

$3,000 BONUS FOR ATLANTA STREET CAR MEN.

The Consolidated Street Railway Company of Atlanta has distributed $3,000 in bonuses to its street car men in sums ranging from $41 down to $5. This bonus was put up in July, in order to encourage the conductors and motormen to better efforts and more care in discharging their duties, both to the company and the public. Those who were to be entitled to a share in the fund should be the men who had been with the company from July to January 1.

A system of fines was also inaugurated against the men for failure to carry out the specific rules of the company. All fines were charged against the men who violated those rules, and the fines made up a fund; both were distributed on a graduated scale.

CAN ELECTRICITY SUPPLANT THE STEAM LOCOMOTIVE ON TRUNK RAILWAYS?—VI.

BY

Wm. Baxter, Jr.

THE cost of repairs to locomotives is great, and in this direction electric motors would make a decided saving. Very few are aware of the magnitude of the cost of maintenance of locomotives, although it is generally understood that the figures are high. A few facts, or, more properly speaking, data, taken from official records, will throw light on the subject.

In the State of Massachusetts, the average cost per year of repairs per locomotive is $1,160, and amounts to about 46 per cent. of the coal bill. On the New York Central Railroad, the repairs to locomotives are given as $1,580,660.01. The amount expended for coal is $3,031,749.77, from which it will be seen that in this particular case the percentage runs up to about 50. As the total operating expenses for the same year are $30,631,732.87, it will be seen that the cost of keeping the locomotives in repair amounts to over 5 per cent of all the other expenses combined.

On the Philadelphia and Reading Railroad the cost of repairs to locomotives is $883,463.47, and the total expenses of operation $11,403,307.37, so that the percentage of repairs to total expenses is over 7 per cent. The Pennsylvania Railroad spends $2,896,735.12 for repairing locomotives out of a total expenditure of $41,003,800.20, which is about 6¾ per cent. The coal bill on this road for the same year is $3,724,481.14, from which we can see that on the Pennsylvania Railroad the cost of keeping locomotives in repair equals about 78 per cent. of the coal bill.

From the few facts given above, it is evident that in the matter of repairs to locomotives there is room for effecting a large saving, as this item will amount on an average to not less than 5 per cent. of all the other expenses. That the cost of keeping motors in repair would fall far below this figure, will be conceded by every one informed on the subject.

Some years ago, Mr. O. T. Crosby, in a very able article on the "Limitations of Steam and Electricity in Transportation," took up this subject and showed by a very logical course of reasoning that the cost of repairs to motors would not be more than 30 per cent. of the amount expended on steam locomotives. His basis of reasoning was exceedingly conservative, and it can be safely assumed that the saving claimed would be more than realized in practice.

Not only in the item of locomotive repairs could the electric system effect a saving, but also in the cost of maintaining the track. This statement may seem unreasonable at first sight, but a brief explanation will show that it is not so. A locomotive is an unbalanced machine and cannot be made otherwise. This fact is well known to steam engineers. The moving parts of a steam engine can be balanced either in a vertical or horizontal direction, but not in both. A locomotive can be balanced vertically by placing a counterbalance weight in the driving wheel, opposite the crank about equal to the crank pin, and half the connecting rod; but to balance it horizontally it is necessary to make this weight equal all the moving parts, that is, the piston, piston rod, crosshead, connecting rod, and crank pin. If the latter weight is used, the machine will be more out of balance vertically than if no weight at all were used; therefore, the best result is obtained by taking a weight that overbalances vertically and underbalances horizontally. As the engine is out of balance vertically, the result is that the track is subjected to a series of shocks, from the effect of which the ties soon become loose in the ballast. As the two cranks are set 90 degrees apart, the unbalanced horizontal weight tends to first swing the locomotive to one side and then to the other. The effect of this is to loosen the spikes, and spread the rails.

As an electric motor is a perfectly balanced machine, it would not produce any of the effects above described on the track; therefore the wear and tear would be very much less. That the difference would be great, will be realized when we consider the difference between a line of shafting on which all the pulleys are balanced and one on which they are not, even if running at a moderate speed. In the former there is no wear except in the bearings, but the latter will soon shake the hangers loose, and will be a constant source of trouble and expense.

The locomotives are not responsible for the whole deterioration of the track, but are the cause of a very large proportion of it, and it is safe to say that the reduction in the cost of maintenance of roadway, due to the absence of the racking effect with electric motors, would be very noticeable.

In viewing the various items in which it has been shown that a saving can be effected in the operating expenses of a road by adopting electricity, we find that we are not confined to the reduction of the coal bill alone. We can also reduce the labor account by doing away with the expense of firemen, by entirely eliminating the expense of maintaining coal and water stations, and by reducing the number of men required to operate the signalling system. We can still further reduce the expenses by the difference between the cost of repairs to locomotives and electric motors, and finally by the reduction in the cost of maintenance of roadbed.

In pointing out the various ways in which the coal bill could be reduced, it was stated that the weight of motors required to haul a train would be considerably less than that of locomotives, and that as less weight would have to be drawn over the road, the power required would be less, and hence the coal consumption less.

Now let us consider to what extent the weight could be reduced. If we were to assume that the steam locomotive must be replaced by an electric locomotive, we would then say that the saving would be the difference between the total weight of engine and tender with an average amount of coal and water, in the latter, and that portion of the weight that rests on the driving wheels only. But it does not follow that the electric system should drop into the footsteps of steam, and replace the locomotive with a machine that would be its counterpart. When this phase of the question is given careful consideration we find that there is every reason why a steam locomotive should be a separate machine, while there is none whatever to justify the making of an electric motor such. A locomotive must have a boiler to supply the steam, and also a water tank and coal bunker. Those parts take up so much room that they must necessarily be made in the form of a separate machine.

But even in steam practice, when the power of the locomotive is small enough to permit it, the machinery is placed at one end of a car, as is the case in dummy engines. The use of a separate electric locomotive is unnecessary, and would only add to the cost of operation as well as to the initial cost of the road. There is ample space on the trucks of a full-size steam railway car, whether freight or passenger, to locate motors of sufficient capacity to do the heaviest work required in railway service. There is no valid objection to such an arrangement, while on the other hand there is every reason why it should be adopted. The weight of the car would give all the traction required, as it would be equal to the weight on the drivers of the largest size locomotives. The motors then could be designed so as to give the maximum output per unit of weight, and, as a result, not less than 5 per cent. of the weight of the steam locomotive and its tender would be saved. On a train like the Empire State Express, where the weight of locomotive and tender amounts to about 37 per cent. of the entire weight, this saving would amount to about 25 per cent. of the entire train.

In addition to the advantage gained by a reduction in weight, locating the motors under one of the cars would do away with the services of one man. An electric motor car, as already stated, can be handled perfectly by one man, but to guard against accidents should the man become disabled in any way, it would be necessary to have an extra man near by to take his place, if necessary. On account of safety, an independent locomotive would require two men. With a motor car such would not be the case. This car, in passenger trains, could be used for baggage, and the baggagemaster could be required to stay with the motorman while the train was in motion, so as to take his place if occasion should arise. The same arrangement could be made with freight trains by making the motor car the conductor's headquarters, and requiring the latter to act as substitute motorman.

Exception may be taken to the statement that by placing the motors on the trucks of a car fully 75 per cent. of the weight of a locomotive of equal capacity could be saved, since to effect such a reduction would require a very high output of energy per unit of weight in motors, more, perhaps, than could be obtained in practice. But any doubt as to the possibility of constructing motors that will fully carry out this assumption can be removed by an investigation of what has already been done in that line. The writer has devoted a large portion of his time during the past four or five years to the work of designing railway motors with special reference to obtaining a large output per unit weight. A 25-horse-power motor that was designed to be mounted directly upon the axle of a street railway car gave a horizontal effort of over 900 pounds when working at its rated capacity, and this could be increased to more than 1,800 pounds for a period of ten or fifteen minutes without danger of overheating. The weight of

the motor was less than 2,200 pounds. It was made for use on a truck having 30-inch wheels, and as it was considered that the lowest parts of the machinery should be at least four inches above the tread of the rail, the vertical dimension of the motor was kept within twenty-two inches.

With trucks of the size used for steam railway cars, very much higher results can be obtained. Not only are the wheels larger, but as the space between rails is not paved, the motors could be made of a height very nearly equal to the diameter of the wheels. Under such conditions the torque at the peripheries of the armature and wheels would be nearly the same, whereas in the case above cited, the armature was only nineteen inches in diameter; therefore the horizontal effort was less than two-thirds of the armature torque.

As a further proof of the possibility of obtaining all the power necessary to draw a train from motors weighing one-quarter of the total weight of a locomotive and tender of equal capacity, I will refer to a set of motors also designed by the writer that have been in use for several years on the Neversink Mountain Railroad, of Reading, Pa. These motors are mounted on trucks having 30-inch wheels. They are of the single-reduction type, and weigh about 2,200 pounds each. The motor car is thirty-four feet long and weighs 22,000 pounds; the trailers are thirty-four feet long and weigh 18,000 pounds. The road is a continuous up-grade for a distance of 3⅝ miles. The grades range from 1½ to 7 per cent., the average being about 3 8-10. The car equipped with these motors has on many occasions drawn up the hill, in addition to itself, a trailer, both fully loaded, the total number of passengers on both cars being 250 and 300.

A simple calculation will show the output of these motors under the above conditions. Taking the number of passengers at 275, and the average weight of each at 110 pounds, we have:

Total weight of passengers, 275 x 110 = ... lbs.	30,250
Weight of motor car .... "	22,000
Weight of trailer car .... "	18,000
Total .... lbs.	70,250

Assuming tractional resistance to be 12 pounds per ton, which is certainly low for this character of road, we would have:

Tractional resistance .... lbs.	421.5
Gravity resistance on 3 8-10 per cent. grade........ "	2669.5
"	3091.0

This is the average horizontal effort, and as the average speed is about 12 miles per hour, the energy developed amounts to about 90 horse-power. To mount the 7 per cent. grade requires an effort of 4917.5 pounds, which makes the maximum horizontal effort 4917.5 + 421.5 = 5,339.0 pounds. As these motors are of the single reduction type their performance cannot be taken as representing what can be done with motors mounted upon the axles, but the performance of such a machine can be estimated with a very fair degree of accuracy by making the proper allowances for the difference in conditions. Thus, as these motors are geared down four to one, the torque, or horizontal effort, if the armatures were on the axles, would be one-quarter of that shown above. It would, in fact, be somewhat more, because the gears absorb in friction fully 6 per cent. Making this allowance, we have:

$$\frac{3091 + (3091 \times .06)}{4} = 819. \text{ and } \frac{5339 + (5339 \times .06)}{4} = 1420.$$

That is, 819 pounds of the average horizontal effort if the armatures were mounted on the axles, and 1,420 pounds as the maximum under same conditions.

AN ELECTRIC RAILWAY FOR CUBA.

Ex-Senator E. H. Hammond, of Orlando, Fla., and Colonel T. J. Appleyard, of Sanford, Fla., have been in Cleveland in consultation with S. T. Everett, of the Everett Electric Railway syndicate. As a result a company will be formed in Cleveland, having for its object the construction of electric street railways in Havana as soon as the war is over, and the ultimate extension of the system throughout the island. Such railroads have been impossible heretofore, owing to the oppressive taxes levied by Spain. The gentlemen interested say that even if the insurgents are not victorious they have assurances that Spain will mitigate many of the conditions which have caused trouble and prevented business progress in Cuba.

THE JOHN SCOTT MEDAL.

Mr. A. Langstaff Johnson, of Richmond, Va., has been awarded by the Franklin Institute the John Scott legacy medal and premium for his bonding joint for electric railways.

TESTS OF A 10-CAR ELECTRIC RAILROAD.

BY JOHN F. VAUGHAN.

THE electric street railway from which these figures were taken consists in a newly built line of single track, ten miles long, running north and south across an open and somewhat hilly country, and an eleven-mile loop, several years old, leaving the main line near the south end and meeting it again about two miles from the north end. A short spin leaves the line near the south end.

The power for this road is derived from a station about three-quarters of a mile south of the south end, occasioning about 25 volts drop before the track is reached, although the station regulation is good. The data may be tabulated as follows:

Miles of track	22½
Number of cars in service	10
Car mileage per day	1,750
Average speed (including stops) .... miles	9½
Average current per car (during run) .... amperes.	20
Watt-hours per car mile (at station)	1,500
Watt-hours per car mile (by wattmeter on car)	1,090
Station potential	560
Average potential on line	448
Maximum drop on line .... per cent.	49
Average feeder losses (calculated) .... "	14
Average ground losses (measured) .... "	15
Line efficiency (at present) .... "	71
Line efficiency (with good bonding) should be "	82
Maximum observed station load (clear cold weather, amperes	450

The bonding on the old line is destroyed in many places, showing over 50 per cent. of the total line resistance in places. The line leakage varied from 2 to 8 amperes, according to the weather. The heaters added, on an average, 8 amperes per car.

A striking example of the effect of the position of the station on the economy of distribution is seen by comparing the above figures with those obtained on the assumption that half the power be taken, as is proposed, from a lighting station between the proper center of distribution and the north end of the line. With the two stations and the same feeder system:

The maximum drop on line....................	22 volts = 3%
Average potential on line	volts 546
Average feeder losses	per cent. 3.1
Probable line efficiency	per cent. 96

JUNGFRAU ELECTRIC RAILWAY INTERNATIONAL COMPETITION.

THE Jungfrau Railway Commission, of Switzerland, has issued the programme of conditions of an international competition for the best solution of a number of questions connected with the construction and working of an electric railway up the Jungfrau. Prizes of a total amount of $6,000 are offered. The points to which attention is called are as follows:

I.—The Design of the Line.—(a) The section of the tunnel, without and with stone lining; the foundation and overhead construction, rails, rack-rail, switches and crossings; (b) the system to be adopted for the electric transmission of the power; equipment of the primary stations; system of distribution of the current along the line; protection against atmospheric disturbances; (c) the electric cars, with all the necessary safety devices; (d) designs for the station building and restaurant at Eigergletscher Station; (e) construction and equipment of the intermediate stations; (f) design of a Klubhütte shelter to take fifty persons at Mönchjoch Station; (g) elevator, about 100 meters high and 8 meters in diameter, provided with staircase, at the summit of the Jungfrau.

II.—The Construction of the Line.—(a) The boring of the tunnel; electric drilling machines, blasting material, ventilation; (b) the removal of the spoil; (c) precautionary measures for the maintenance of health and life of the workmen, patterns of movable barracks.

III.—The Working of the Line.—(a) Plans for insuring under the given conditions a continuous working of the line; (b) electric lighting of the tunnel, cars and stations; (c) electric heating of the cars and stations, precautions for the safety of passengers and working staff.

One or more of the above points may be dealt with by a competitor or several competitors collectively. Further suggestions likely to be of advantage to the Jungfrau Railway undertaking are also invited.

The Scientific Commission, with the assistance of experts, will settle the award of the prizes. The results will be pub-

lished. Upon the prizes being distributed the Jungfrau Railway Company will acquire the right to use the plans obtaining prizes without further compensation. The commercial copyright will, however, remain the property of the author. Rejected papers will be returned.

The following data are given: The maximum gradient of the line is 25 per cent. The gauge is 1 metre. The sharpest curve is 100 metres radius, and the maximum radius is 500 metres. The greatest width of car must be 2.5 metres, the greatest height 3 metres, the maximum speed 7 to 10 kilometres per hour. The water power at the disposal of the electrical plant is about 5,000 horse-power, and will be taken from the River Lütschinen. The distance between the power house and the starting point of the line on the Kleine Scheidegg is about 8 kilometres; from there to the tunnel entrance it is 2½ kilometres, and the tunnel has a length of about 10 kilometres.

Competitors must illustrate their schemes by drawings or models, and must also enclose estimates of costs. The latest date for sending in schemes is Aug. 1, 1896.

Further information may be obtained from Bureau der Jungfraubahn, Bahnhofstrasse 10, Zurich, Switzerland, where also general plans, the result of geological investigations and details of the water power available may be obtained.

The Scientific Commission of the Jungfrau Railway will consist of Professor Becker (Zurich), H. Brack, technical director of the North East Railway (Zurich), Professor Golliez (Lausanne), Dr. Maurer (Zurich), Dr. L. von Salis-Guyer (Basle), Dr. Schmid (Berne), Rev. G. Strasser (Grindelwald), E. Strub, railway engineer (Interlaken), Professor Walder-Meyer (Zurich), Professor Weber (Zurich), Dr. Wrubel (Zurich), and President Guyer-Zeller.

MORE ELECTRIC MOTORS FOR THE BROOKLYN BRIDGE.

At the meeting of the bridge trustees on March 23 the plans for the introduction of electric power on the railroad were outlined in this report from Chief Engineer Martin, which was received and approved:

"Since the last meeting of the board I have conducted a series of observations upon the operation of the motor car in use, with the result that it has been determined to use motors of 25 per cent. greater capacity than those on the present motor car and to somewhat differently arrange the electrical units in the power house and increase their capacity 20 per cent.

"With the equipment increased, as shown, the plant will readily do the switching of trains running on forty-five seconds headway, and in case of failure of the cable, it will be capable of running four-car trains at intervals of sixty seconds. With the transportation equipment, consisting of a double cable, gauntleted tracks, and the above described electrical plant, it seems to me that we shall be in an ideally perfect condition to carry absolutely the maximum number of passengers that the bridge railway can be made to carry. Although even the maximum carrying capacity of the bridge will in all probability never again be equal to or exceed the heavy demands made upon it during the rush hours, it will meet, as far as it is possible for this one bridge to meet, the ever-increasing demands for transportation between New York and Brooklyn.

"The plant required to put the bridge railway system in perfect condition will be a power house about 100 feet square, engines of a capacity of 2,500 horse-power, boilers sufficient to supply steam to them, electrical generators of about 1,600 kilowatts capacity, and with all the paraphernalia of a first-class power house. It is proposed to locate the power house on property owned by the bridge trustees and situated at the corner of Dock and Water streets.

"The car equipment will consist of four motors, each of which will be able to exert a drawbar pull of 1,500 pounds, and they will be arranged so that any number of them can be operated independent of the rest. All of the ordinary and well-tested devices will be installed to insure certainty and regularity in the operation of the electrical appliances.

"I have made an approximate estimate of the cost of the new power house and plant complete, and it will be about $300,000. I have made all estimates liberal, and feel sure that the figures given will not be exceeded. This does not include the new cars that will be required. Neither does it include the heating equipment on the cars for heating by electricity. The above estimate provides for the equipment of twenty cars."

At the next meeting the trustees are to submit the plans for the power house, and on their approval bids will be at once advertised for.

The Executive Committee reported that the contract for the equipment of twenty cars with electric appliances had been awarded to the General Electrical Company, at $3,645 each.

SALE OF THE CITY OF MEXICO STREET RAILWAYS.

The City and Suburban Tramway system of the City of Mexico was bought recently by Mr. H. A. Butters, representing London and South African capital. The purchase price is stated at $7,750,000, payable in installments, one of which is $6,000,000 in 6 per cent 20-year mortgage bonds. The system includes about 200 miles of steam and animal traction lines, and it is the intention to equip with electricity, using, perhaps, the drainage canal, for 6,000 horse-power. The consulting engineers are W. W. Page, of London, and T. W. Orbison, of the firm of O'Keefe & Orbison, of Appleton, Wis.

A TROLLEY ROAD FOR TEHERAN, PERSIA.

It is stated that the first trolley railroad in Persia will be built from Teheran to the summer resorts, about ten miles to the north of the city, where everybody lives during the hot season. The summer on the Persian plateau is very hot and dry, and it is only in the neighborhood of the mountains that Europeans can stand the great heat. A concession for ninety years has been granted to a German contractor, who will start the building of the road at once.

ELECTRICITY FOR ENGLISH LIGHT RAILWAYS.

At the London Imperial Institute, Mr. W. J. Brewer recently read a paper on "Light Railways; Their Construction and Working." After many years' experience in railways, he was convinced that there was nothing to compare with a properly-organized system of feeders for the main lines of railway. By the aid of electricity, it would be possible to supply both power and light, not only for the lines, but for the towns and villages on their route. The lines would be a means by which a system of telegraphs and telephones could be established at a slight expense, and they would add to the income. In his opinion, the new "autocar," in the interests of the agricultural classes, would never do the work of a light railway, simply because no road could ever equal the surface of a rail. It was absurd to argue that these feeder lines should be of the same gauge as the main lines. The loads on the cars of the feeder lines could be so arranged as to be moved from the feeder car to the main line car with the least possible amount of trouble or waste of time. As a motive power, he took his stand by electricity. The materials comprising the car, motors, standards for carrying the electric conductors, rails, and other necessary equipment, should be manufactured on the duplicating system, so as to reduce first cost and facilitate renewal.

NEWS AND NOTES.

PLATINUM IN NEW SOUTH WALES.

It is agreeable to note the well accredited statement that large deposits of this valuable mineral have been discovered at Fitfield, New South Wales. It has been known for several years that platiniferous lead existed, and the deposits have been worked, though only on a small scale. It is now found however, that the platiniferous lead is over a mile long, varying in width from 60 feet to 150 feet, and covered with from 60 feet to 70 feet of loam. The precious metals are practically confined to the bedrock and the drift for 3 inches above the bottom. Nuggets which weighed from a few grains up to 5 dwt. have been occasionally found. The crude metal contains about 75 per cent. of platinum, and realizes upon the field nearly $5 per ounce.

ELECTRIC PROPERTIES OF COMETS.

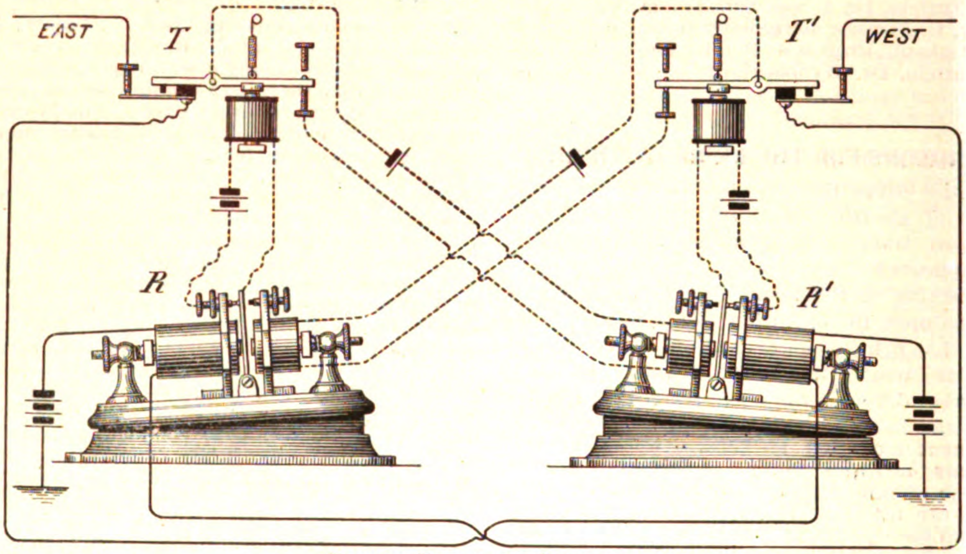
In a recent number of the "Astrophysical Journal" Professor Fessenden suggests that the ultra-violet rays falling upon that side of the nucleus which is turned towards the sun cause negatively-charged particles to be emitted, the nucleus remaining positively charged. Researches by Professor J. J. Thomson indicate that the solar chromosphere is negatively electrified; and the spectra of cometary tails, resembling as they do the candle spectrum, support the hypothesis of negatively electrified tails. There will, then, be four forces acting on the particles projected from the inner surface of the nucleus—namely, the solar electrical repulsion, the mutual electrical repulsion, the electrical attraction of the nucleus and gravitation. These forces will determine the form of the tail; and it would seem that all the special differences in comet structure are capable of explanation on the hypothesis. A solar potential of about 15,000 volts is apparently required.

Telephony and Telegraphy.

HORTON'S TELEGRAPH REPEATER.

MR. L. HORTON, JR., superintendent of the Philadelphia and Reading Railroad Company's telegraph system, has recently been granted a patent on a telegraph repeater, which has found great favor among telegraph men generally on account of its simplicity, compactness and effective working, and which has already been adopted by the Lehigh Valley Railroad, Philadelphia and Reading Railroad, and National Transit Company, and is in use on the lines of the Western Union Telegraph Company, Long-Distance Telephone Company, North American Telegraph Company, and Pennsylvania lines west of Pittsburg. The distinguishing feature of this repeater is the method adopted for preserving the continuity of the sending circuit while the opposite line is being repeated into, which Mr. Horton accomplishes in a remarkably simple and effective manner by the utilization of the force of gravity, dispensing with all extra armatures, springs or other mechanical contrivances, the holding force being obtained by the withdrawal instead of the application of a local current.

The principle and operation of the repeater will be readily understood by reference to the accompanying illustration in which T and T' are ordinary repeater transmitters of the usual form with front and rear contacts arranged for repeating into their opposite lines, and also for actuating the retracting magnets of opposite relays. R and R' are main line relays, differing from the ordinary relay only in the inclined base and the addition of the local retracting magnets which are placed directly behind the relay armature occupying the same relative position as the main line magnets in front and acting, when energized, upon the armature as a retractile force (in place of the usual spring) to draw it backward and away from its local contact when the main line current through the front coils is interrupted, and when demagnetized to prevent such movement of the armature which, under this condition, remains motionless upon its front or local contact regardless of the presence or absence of a current through the main line coils in front; the inclined base on which the relay rests causes the armature to retain its forward position by the force of gravity at such times as both sets of coils may be demagnetized, and thus keeps its neighboring transmitter closed.



Horton Telegraph Repeater.

These retracting magnets being adjustable with reference to their position with the armature, are drawn toward or away from the latter, as it is desired to increase or diminish their force upon it, in precisely the same manner as the tension of the spring in the ordinary relay is regulated; and it will be seen that this is the only part of the repeater requiring adjustment.

The arrangement of circuits, as shown in the diagram, is as follows: The eastern circuit is brought to the post of transmitter T, and from there when the transmitter is closed, through relay R' to battery and ground. The western circuit is brought to the post of transmitter T', and thence through relay R to battery and ground. Both lines being represented as closed, the action of the repeater is as follows: A distant office on the western line opening its key interrupts the current through the relay R, the armature of which is thereupon drawn away from its local contact by the action of its retracting magnet, permitting its neighboring transmitter T to open, which, in turn, opens first the local circuit of retracting magnet of relay R' and next the eastern circuit at its spring contact.

The opening of the extra local circuit demagnetizes the retracting magnet, thereby preventing any movement of the armature of relay R', which is held against its front or local contact stop by its own weight when the main line through the front coils is opened an instant later, transmitter T' being thus kept closed, preserving the local circuit through retracting magnet of relay R, and providing a path for the western circuit through spring contact of transmitter T', relay R and battery to ground to enable the distant western office to close relay R again.

When the western office closes its key the armature of relay, R, is again attracted forward, closing the local circuit of transmitter, T, which in turn closes first the eastern circuit at its spring contact and next the local circuit of relay R's retracting magnet.

The means employed for keeping the relays on either side closed during the time their respective circuits are being repeated into accomplishes the result most effectively without the use of extra armatures requiring special adjustment, the adjustment being thus simplified to that of an ordinary relay.

The advantages of this repeater are:

1. Its thorough efficiency as a repeater, the absence of all extra armatures and springs from the relay, rendering the latter extremely sensitive and permitting the closest possible adjustment of both relay and transmitter armatures, the play of which may be shortened up so that their motion is scarcely perceptible, which, together with the instantaneous application of the holding force, greatly increases the capacity of the repeater for rapid work. Any very marked decrease in strength of extra local current, which is fatal to the operation of most forms of repeaters, can be instantly and fully compensated for in this instrument by simply giving the adjustment screw of the retracting magnet a turn to bring it closer to the armature, and as the holding force is in no sense dependent upon the strength of current, any variation in the same can have no possible effect upon this function of the instrument.

2. The very small amount of attention required during its operation, the adjustment seldom requiring change, and the ease and simplicity of adjustment, which insures better results in the hands of ordinary operators than most forms.

3. Small amount of battery required with resultant economy in maintenance, one cell of extra local for each retracting magnet being sufficient as against six cells usually employed in the Milliken, for example, in addition to which it is found that the transmitters can be operated on less battery consequent upon their close adjustment. It is said that a saving of about ten cells of local battery can be effected at each repeater where this form takes the place of a Milliken repeater.

It will be readily seen that this repeater can be divided into half sets and operated in connection with duplex or quadruplex systems with the same facility as other forms not possessing its advantages.

LETTERS TO THE EDITOR.

ELECTRICAL INSURANCE RULES FOR STREET RAILWAYS.

"At the recent formation of the National Conference on Standard Electrical Rules, in common with the electrical interests, the American Street Railway Association was represented, and for the first time was consulted with regard to the various electrical rules now enforced by the insurance companies. The following committee was appointed to formulate a new code of rules to be submitted to the next meeting of the National Conference, June 25 and 26: Francis B. Crocker, chairman, representing American Institute Electrical Engineers; William J. Hammer, ex-officio President National Conference on Standard Electrical Rules; Frank R. Ford, American Street Railway Association; William H. Merrill, National Board of Fire Underwriters; Alfred Stone, American Institute of Architects; E. A. Fitzgerald, Underwriters' National Electric Association; William Brophy, National Electric Light Association; E. V. French, Associated Factory Mutual Insurance Companies.

The undersigned, as representing the American Street Railway Association, has been requested to secure suggestions from the members of the association, and from all other street railway companies, engineers and allied manufacturing interests, with respect to such changes or additions to the present rules that may seem advisable.

The importance of this work, in its bearing upon street railway construction and the opportunity now offered to street railway interests for the first time to participate in a movement in which they are so vitally concerned, should not be overlooked. The Committee on Rules depends upon the active co-operation of all parties at interest in order to secure a full presentation of all changes that might be beneficial in the formulation of a new code.

The present rules relating to electric railways are as follows:

Electric Railways.

"RULES FOR SAFE WIRING.

"37. All rules pertaining to arc-light wires and stations shall apply (so far as possible) to street railway power stations and their conductors in connection with them.

"38. Power Stations:—

"Must be equipped in each circuit as it leaves the station with an approved automatic 'breaker,' or other device that will immediately cut off the current in case the trolley wires become grounded. This device must be mounted on a fireproof base, and in full view and reach of the attendant.

"Automatic circuit breakers should be submitted for approval before being used.

"39. Trolley Wires:—

"(a) Must be no smaller than No. 0. B. & S. copper, or No. 4. B. & S. silicon bronze, and must readily stand the strain put upon them when in use.

"(b) Must be well insulated from their supports, and in case of the side or double-pole construction, the supports shall also be insulated from the poles immediately outside of the trolley wire.

"(c) Must be capable of being disconnected at the power house, or of being divided into sections, so that in case of fire on the railway route the current may be shut off from the particular section and not interfere with the work of the firemen. This rule also applies to feeders.

"(d) Must be safely protected against contact with all other conductors.

"40. Car Wiring:—

"Must be always run out of reach of the passengers, and must be insulated with a waterproof insulation.

"41. Lighting and Power from Railway Wires:—

"Must not be permitted, under any pretense, in the same circuit with trolley wires with a ground return, nor shall the same dynamo be used for both purposes, except in street railway cars, electric car houses and their power stations.

"42. Car Houses:—

"(a) Must have the trolley wires properly supported on insulating hangers.

"(b) Must have the trolley hangers placed at such a distance apart that in case of a break in the trolley wire, contact cannot be made with the floor.

"(c) Must have cut-out switch located at a proper place outside of the building, so that all trolley circuits in the building can be cut out at one point, and line circuit breakers must be installed, so that when this cut-out switch is open the trolley wire will be dead at all points within 100 feet of the building. The current must be cut out of the building whenever the same is not in use, or the road not in operation.

"(d) Must have all lamps and stationary motors installed in such a way that one main switch can control the whole of each installation (lighting or power), independently of main feeder switch. No portable incandescent lamps or twin wire allowed, except that portable incandescent lamps may be used in the pits; connections to be made by two approved rubber-covered flexible wires, properly protected against mechanical injury; the circuit to be controlled by a switch placed outside of the pit.

"(e) Must have all wiring and apparatus installed in accordance with rules under Class B.

"(f) Must not have any system of feeder distribution centering in the building.

"(g) Must have the rails bonded at each joint with not less than No. 2 B. & S. annealed copper wire; also a supplementary wire to be run for each track.

"(h) Must not have cars left with trolley in electrical connection with the trolley wire.

"43. Ground Return Wires:—

"Where ground return is used it must be so arranged that no difference of potential will exist greater than five volts to fifty feet, or fifty volts to the mile between any two points in the earth or pipes therein."

At the meeting of the National Conference a number of topics were suggested that might advantageously be incorporated into the new rules. Some of these are here presented for the consideration of street railway interests merely as an indication of general lines upon which there may be necessity for revision, and with the hope that they may evoke a very general expression of opinion from all concerned: Increased protection of lighting circuits; method of grounding generators; double insulation for trolley wires with iron pole construction; car wiring in moulding and interior conduit; automatic magnetic circuit breakers for cars; electric brakes; electric car heaters; use of lights from railway circuits in buildings operated by street railway companies, such as amusement pavilions, repair shops, waiting rooms, etc.; rail bonding; arc lamps on railway circuits.

It has been suggested that the new rules should cover very fully the subjects of car wiring and outside construction. They should deal not only with the construction objectionable from the standpoint of fire hazard, but also with respect to personal danger.

All suggestions should be forwarded at an early date, in order to secure full discussion, as the committee has but a limited time in which to consider and report upon recommendations to the Conference. FRANK R. FORD,
203 Broadway, N. Y.

March 24, 1896.

DR. PUPIN ON THE EDISON FLUOROSCOPES.

Messrs. Aylsworth & Jackson, of East Orange, N. J., presented me, on behalf of Mr. Thomas Alva Edison, with a tungstate of calcium fluoroscope. It is a magnificent piece of apparatus, and will undoubtedly prove of the greatest service in the new field of work opened up by Röntgen's discovery. I cannot speak too highly of its merits, and I take much pleasure in recommending it to all who are interested in Röntgen radiance. I wish to state also that this recommendation is spontaneous, and not in any way suggested or even hinted at by the generous donors.

Mr. Edison and his assistants—Messrs. Aylsworth & Jackson—deserve the deepest gratitude on the part of scientific men and the public at large for their magnificent fluorescent screens. M. I. PUPIN.

Faculty of Pure Science, Columbia University, New York.

AN INVALUABLE NECESSITY.

I enclose herewith my check for $3 for one year's subscription to "The Electrical Engineer." I beg to say that your valuable paper has become a necessity to me, and I consider the information I glean from its columns invaluable to me.

I must congratulate you on the exceedingly interesting articles which have appeared of late. I must especially commend you on the issuing of the "Data Sheets" and the information contained therein, and I consider that "The Electrical Engineer" stands pre-eminently at the head of the engineering journals.

Your recent issues relating to central stations have been very interesting.

Trusting you will keep on with the good work, I remain, yours very truly. PAUL H. BRANGS,
Electrical and Gas Engineer.

Hoboken, N. J., March 18, 1896.

MR. B. J. WOOD, of Babylon, L. I., has been appointed superintendent of the lighting plant of the Manhattan Beach Improvement Company, Coney Island.

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CONTENTS.

ROENTGEN RAY EXPERIMENTS.

WHILE the interest, amounting almost to excitement, created among the general public by the discovery of Prof. Röntgen has almost subsided, such, we are glad to say, is not the case among scientists and inventors, who have at their disposal apparatus for carrying on experimental work of this nature. This is evident on glancing at the continuing contributions on the subject appearing in our columns. Indeed, the further study is pushed in this direction, the more it becomes certain that the Röntgen ray phenomenon will require the most careful investigation before its true character can be established. Already experiments seem to cast a doubt on the original belief as to the source of these rays, eminent experimenters, like Prof. Rowland and Prof. Elihu Thomson throwing the weight of their opinion in favor of the anode. Dr. Morton, with a very characteristic photograph, has shown that in his particular experiment the source of the X-rays was confined to a limited point of fluorescent material within the tube between the anode and cathode. It will be remembered that Prof. Röntgen, in his original essay, pointed out that the chief seat of the rays was located at the most brilliant phosphorescent spots on the walls of the tube, and was to that extent independent of either cathode or anode. For those who have not followed the history of the Röntgen ray we can strongly recommend the perusal of Mr. Osterberg's admirable résumé of the subject embodied in his lecture before the New York Electrical Society. We agree fully with Mr. Osterberg in recommending to all at work on, or about to undertake Röntgen ray experiments, to read carefully Prof. Röntgen's essay, which appeared in our issue of Feb. 12. As a collateral branch of investigation, much interest has been concentrated in fluorescent bodies, and investigators will, we ascertain, be grateful to Mr. Edison for having called attention to the tungstate of calcium, a material far more powerful than what had heretofore been commonly used.

In line with Röntgen ray experiments is the alleged discovery of a means for rendering transparent opaque objects placed in a certain position with regard to a number of chemical solutions. The description of this new development, as far as the inventor has permitted its publication, is given on another page. While, of course, we can not guarantee the authenticity of the story, we have given it on the testimony of reliable witnesses, and present it to our readers for what it is worth.

THE BOARD OF FIVE.

THE more the recent alliance between the General Electric and Westinghouse companies is discussed, the more it becomes apparent that a nearer union than that of mere patent licensing is probable. The proposed Board of Five is apparently a power that rises superior to either individual company, in that it constitutes a joint executive committee of both. Such a committee under any normal state of affairs would have pretty continuous occupation, even on the skeleton lines indicated in the formal announcement. But there is reason to believe that prices not less than patents are in the minds of the devisers of the alliance. Unless we are misinformed, it is an old plan of Mr. Twombly's to have a Board of Five to control matters generally. This board was not only to control prices, but all important contracts were to be submitted to it. That this should gradually appear to be the

real intention now under the new regime will not be surprising.

The task before the "Big Five" is herculean. Stated in a few words, it is nothing less than undertaking to earn dividends on a capital of $60,000,000, or more, in a field where competition is already active and is likely to become rifer. We discussed last week the various appliances that are free in the field of electricity, and while almost everything was enumerated, we have still to learn that our views are erroneous. Prices cannot, therefore, be cut, if dividends are to be paid on $60,000,000. If prices are maintained at the point where the "combine" can make an average profit of twenty per cent. on everything it sells, it must do an annual business of $25,000,000 in order to pay eight per cent. on its $60,000,000. At the same time, if there is $25,000,000 of business going at a margin of twenty per cent. profit, we think the alert, intelligent, industrious and specially informed manufacturer, on an independent basis, and devoting his whole energies to one or two lines is likely to get a large share of that trade.

It seems to us that this period is peculiarly favorable to the independent manufacturers. To begin with, the public sympathy and that of the whole electrical trade, is with them. Nobody likes to be compelled, under duress, to deal with one man or one concern. That is sheer industrial slavery, unless based on the merit of the goods, so that if one could, one would not go elsewhere to effect a purchase. Not only is the law against combines in restraint of trade, but public opinion and public action go further than the law. Moreover, the protean, plastic nature of electricity itself, is all the time making for greater conditions of freedom, and each achievement in the field, so far from tying up the art, simply promises a dozen new conquests. The manufacturer to-day who has a good thing, who pushes it boldly and who advertises it freely, will suffer from no want of general support. Parsimony and lack of courage are the things he has chiefly to fear, for if the field is let alone the "combine" will get the business, no matter what the quality of its goods might be.

THE INCANDESCENT FILAMENT AND THE WELSBACH AND ACETYLENE FLAMES HYGIENICALLY COMPARED.

DR. W. H. BIRCHMORE'S contributions on hydro-carbon flames, which have recently appeared in these columns, afford much material for those who are interested in defending incandescent lighting by electricity against the assaults of the gas interests. Taken in connection with his paper on the Bunsen burner spectrum, they cannot but remind our readers of what has been so often said about the danger to the eyes from the actinic rays given off by the intensely heated carbon gases of the regenerative burners and the Welsbach light. The peculiarly dangerous character of this last from the great volume and degree of its chemical radiation has been stated before, but the reason has never, so far as we are aware, been made quite so apparent. If this series of contributions is read consecutively, the following deductions are obvious, and should be forcibly stated by every one who is interested in the business of electric lighting:

1. These investigations show conclusively that the radiation from incandescent gases is dangerously rich in chemically efficient rays. Considered in relation to the eyes, therefore, the light from any solid heated by, and surrounded with, an envelope of incandescent gas, is hygienically bad and dangerous to the eyes. 2. The incandescent carbon of the ordinary gas flame, simply because it retains the flame at a lower temperature, and thus keeps down the radiation of the actinic influence given off by high temperature gases, is a useful check, while with the Welsbach mantle and other appliances of the same sort, there is no limit to the temperature possible, and no check exists in the nature of the case itself. 3. The incandescent filament, while rich in chemically efficient rays too rich for choice, contains less than a twelfth of the chemical rays in an oil flame of the same "visible radiation value," and not two per cent. of the amount given off by a Welsbach of the same nominal candle power. 4. There is a difference, not of degree only, but of kind, in the chemically efficient rays coming from the Welsbach and the filament, which will some day be better understood. 5. There is also an especial reason why the light from the acetylene flame is bad for the eyes. Not only is it of remarkable actinic power, but it is rich in the fourth sort of chemical rays—a kind which not only decomposes the yellow pigment of the eyes with a startling rapidity, but which prevents its formation to such an extent that the eyes are disabled from correctly appreciating colors by daylight after a prolonged use of the light of this flame.

There is no sort of doubt that if these facts are presented by those having electric light interests in charge to the attention of an intelligent public the use of the filament as a source of light must increase rather than diminish in the competition with the new and "improved" means of illumination by gas.

THE COMING EXPOSITION.

THE preliminary list of exhibitors given out this week by the officers of the National Electrical Exposition, soon to be supplemented, we are informed, by another list of large proportions, is enough in itself to indicate that the affair will be the success we all desire. The exhibits will evidently be large, varied and comprehensive, and, together with the many special features that are to be added by the management itself, will do more to educate the public in the general use and appreciation of electricity than anything else that has been done these ten years past. It will be noted that in the departments of steam power and current generation, the list is remarkably strong, and this is in itself very satisfactory, for the average citizen has still much to learn in that respect. When he sees how simple the mechanism and modus operandi is, he will be the quicker to inquire why he is still debarred from the service of this modern agency in his home and business for the larger uses of comfort and convenience.

Other features of the Expositon are not less hopeful, as, for example, Mr. Edison's generous intention, not only to contribute largely to the historical and loan exhibit, but to place freely at disposal several sets of fluoroscopes and Röntgen ray apparatus, so that everybody can see the whole thing and try the new process of internal inspection for himself. In fact, now that the management has been so successful in disposing of its space, and thus in providing very properly for financial success, it may well give as much attention as possible to the educational side of the great show. That in turn will prove remunerative, not alone immediately to it, but in the long run to every exhibitor.

ELECTRIC LIGHTING.

FURTHER EXPERIMENTS IN FLUORESCENCE UNDER THE CATHODE RAY.

BY

Thomas A. Edison.

FURTHER experiments with the fluorescence of different chemicals under the influence of the X-ray have added a few more to the list already published. The following fluoresce: Cadium tungstate, tungstate of zinc, lithia benzoate, tannate lead, carbonate lead, salicylate potassium, carbonate silver, sodium salicylate, sodium carbonate, sodium tungstate, zinc acetate, zinc chloride, zinc carbonate, molybdate zinc, benzoic acid, malic acid, diphenylamine, ruffigallic acid, pyridin nitrate.

I have so far found no salt in the following metals to fluoresce: Aluminum, antimony, arsenic, boron, beryllium, bismuth, cerium, chromium, cobalt, copper, gold, iridium, magnesium, manganese, nickel, tin, titanium.

The crystals of the following chemicals give spots of light when held close to the bulb within a dark box. The light has the glowworm color of phosphorescence, and is due to the electric discharge and not to the X-ray: Ammonium, sulphocyanide, calcium formate, calcium nitrate, iron citrate, silver nitrate, soda, lime, zinc, cyanide, zinc hypermanganate, zinc valeriate.

THE EDISON FLUOROSCOPE IN USE.

With plates of fluorite I have found that the phosphorescence penetrates the plate very slowly. If held before a fluorescing tube for one minute, the phosphorescence penetrates for 1-16 of an inch deep in the plate. This part, when held edgewise, is brilliant; beyond is dark.

(The latest form of fluoroscope designed by Mr. Edison is that illustrated in the accompanying engraving. It consists of a flaring box, curved at one end to fit over the forehead and eyes, like a stereoscope. The end of the box is closed by a pasteboard cover, on the inside of which is spread a layer of tungstate of calcium, which material Mr. Edison reports he has found to possess six times the fluorescing power under the influence of the X-rays, as compared with barium platino-cyanide.

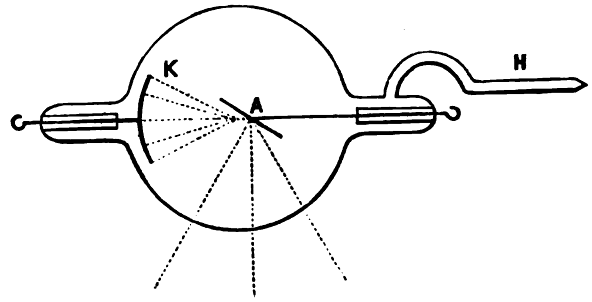
By placing the object to be observed, such as the hand, between the vacuum tube and the fluorescent screen, the shadow is formed on the latter and can be observed at leisure. In order to exclude all light from the screen, the curved part of the fluoroscope encircling the eyes is lined with black ostrich feathers, so that the experiments can be carried on in broad daylight, if desired.

These fluoroscopes are manufactured by Messrs. Aylsworth & Jackson, of Orange, N. J., who have very kindly placed one of them at our disposal for illustration. EDS. E. E.

A NEW X-RAY "FOCUS" TUBE.

A NEW tube for producing the X-rays has recently been designed by one of the professors at King's College, London, which, according to the London "Electrical Review," is so great an improvement on anything in this line that has been previously produced, that it will undoubtedly give a great impulse to the practical applications, especially to surgery, of the new photography.

The cathode rays are focused to a point where they impinge on a plate of platinum fixed on the anode. The X-rays radiate from this point, and, of course, produce a much sharper shadow of the object being photographed than when radiating from the extended luminous patch on the glass of the tube which has hitherto generally been used. Fig. 1 shows a section of the "focus" tube. The cathode plate, K, is a concave disc of aluminum which focuses the cathode rays at a point near the center of the bulb. The anode plate, A, is a small



NEW RONTGEN RAY FOCUS TUBE.

piece of platinum foil placed at an angle a short distance beyond the focus of the cathode rays. Curiously enough, the cathode rays do not cross like rays of light at the focal point, but behave rather like a number of fluid jets coalescing at the focal point, and proceeding thence onwards as a solid parallel jet. The point where the rays impinge on the platinum still retains its small dimensions, though the plate is placed some distance beyond the focal point.

Platinum is known to be one of the most opaque substances for the cathode rays, and thus very little of the radiation passes through the platinum foil. The greatest part of the radiation is absorbed by the platinum, and given out as X-rays from the luminous point by a kind of diffuse reflection. The anode plate, A, being set at an angle, the best part of the radiation is directed downwards through the sides of the bulb, where it can be conveniently utilized to produce the photograph in the usual way. The tube, H, through which the bulb is exhausted, is shaped so as to permit the tube to be fixed in a stand at the required height. The anode and cathode plates are connected to the terminals of the induction coil by platinum wires fused through the glass.

ROENTGEN RAY LITERATURE.

THE "Comptes Rendus" for February 17 contains, as usual, numerous communications on the subject of Röntgen rays. M. R. Swyngedauw has a communication on the subject of the lowering of the sparking distance. MM. L. Benoist and D. Hurmuzescu present a paper in which they state that they have verified that Röntgen rays are propagated in air according to the law of inverse squares. They also state that the Röntgen rays are heterogeneous. They base this statement on the fact that they find the coefficient of transmission for a 0.1 mm. thickness of aluminum to be about 0.85, and they go on to say that such a value is absolutely incompatible with the very sensible transparency that Professor Röntgen observed for a plate of aluminum 15 mm. thick, if we assume that the coefficient is independent of the Crookes tube employed, and if it does not increase with the thickness traversed—that is to say, if X-rays are not subjected when passing through aluminum to selective absorption, which is a proof of heterogeneity. If the value 0.85 were constant the total transparency of a

sheet 15 mm. thick would be represented by 26×10^{-12}. MM. Benoist and Hurmuzescu then carried on experiments with increasing thicknesses. They found that the coefficient increased from 0.85 for sheets not exceeding 0.6 mm. thick, to 0.9 for sheets exceeding 1 mm. They next employed different Crookes tubes under identical conditions, and found that the coefficient of transmission varied from 0.85 to 0.78. Another communication was made by MM. Auguste and Louis Lumière describing some experiments carried out by them with a view of ascertaining the amount of absorption which Röntgen rays undergo when passing through sensitive films. After ten minutes' exposure they found that photographic effects were produced through a packet of 250 sheets of gelatino-bromide-silver paper; they further found that 300 sheets of paper without the bromide emulsion exercised the same absorptive effect as 150 sheets of sensitized paper. They then experimented with photographic plates having different degrees of sensitiveness for white light in the ratio of extent of 1.8 to 30, and they found that within the limits of their experiments this ratio was exactly the same for Röntgen rays.

OPAQUE OBJECTS MADE TRANSPARENT BY RAYS PASSING THROUGH CHEMICAL SOLUTIONS.

We have received from a correspondent at Parkersburg, W. Va., an account of an alleged remarkable discovery which, if verified, places it well on a par with the now famous discovery of Professor Röntgen. The discovery referred to is due to Mr. A. G. Davis, of Parkersburg, and consists in an arrangement of chemical solutions, the effect of which is to make opaque bodies transparent to light.

The discovery is said to have come about in this way: Mr. Davis, who is a jeweler by trade, was engaged in soldering, seated at a table with three bottles of chemicals before him. In one hand he held a fourth bottle and in the other a file. By accident, he held the file between the bottle in his hand and the three bottles on the table, and, much to his surprise, only the ends of the file were visible. A number of other objects, including the hand, were tried, all appearing transparent. The accompanying engraving, Fig. 1, shows the first apparatus constructed by Mr. Davis, consisting of two end boxes containing the bottles of chemical solutions, with what is said to be a solid block of steel 12 x 18 x 25 inches between them. The internal arrangement of the end boxes is shown in Fig. 2, which exhibits their contents exposed. Both these boxes in their latest form have glass fronts and backs. The box on the left hand is the one containing the single chemical and which is the one placed next to the observer. The bottle has two wires connected to it which extend to a metal plate inside of the small box shown above the bottle. A crank is so arranged that by turning it the contents of the bottle are shaken, and this agitation is said to produce the effect of making the metal plate inside the small box transparent.

The box farthest from the observer is shown at the right in Fig. 2. This also contains a small auxiliary box, tightly

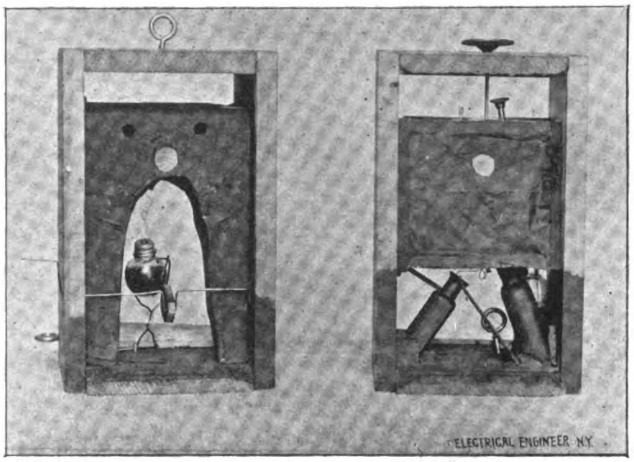


Fig. 2. The Boxes Exposed.

closed, with a one-inch aperture and piece of tinfoil back of it and a piece of windowglass over it. This small auxiliary box also contains a metal placed behind the aperture, and from the plate wires extend to the bottles shown. In order to avoid the suspicion that the results may be due to an arrangement of concealed mirrors, placed in the board supporting the two boxes and block of steel, in the latest arrangement the two boxes are entirely independent of each other. In a communication received from Mr. Davis himself, that gentleman writes: "I have found by a combination of four chemicals that I can make transparent any opaque object, one being on one side of the opaque object and the other three on the other side. I have further made a second and later discovery, that the powers of the chemicals can be transmitted by means of small wires to a metal plate, which, if enclosed in a dark box, makes a sort of fluorescent screen, and by looking through it all opaque objects become transparent the same as if looking through the one bottle of chemicals.

"I will not reveal the name or nature of the chemicals, nor

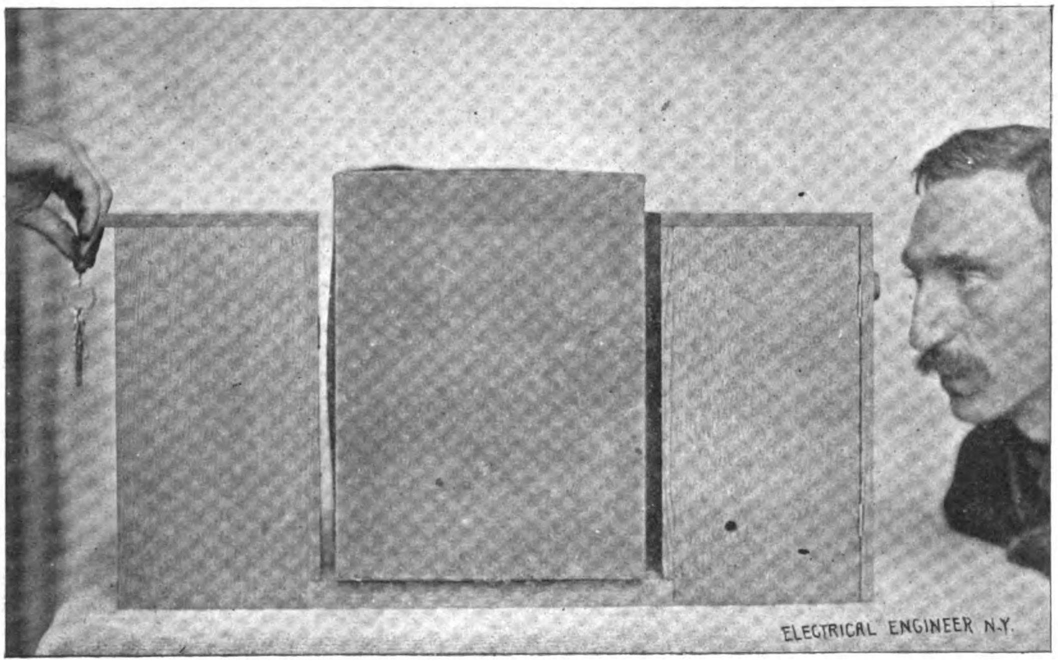


Fig. 1. Davis's Method of Viewing Objects Through Opaque Bodies, by the Aid of Chemical Solutions.

Photograph by Emil Korb, of Parkersburg, W. Va.

the metal plates, but hundreds here in this city have seen their results. In order to conceal their identity, I enclosed them in two closed boxes on the two ends of a board in order to keep them in darkness, as I find that the sunlight had a weakening effect on their powers.

"The later metal discovery enabled me to allow the chemicals to remain in the light, but I must keep the metal in the dark box, as shown in the engravings."

THE PIONEER INCLOSED ARC LIGHT FOR INCANDESCENT CIRCUITS.

OUR readers will recall that at the National Electrical Congress held in Chicago in 1893, Mr. L. B. Marks, the well-known carbon and arc light expert, read a paper on the inclosed arc light. The paper made considerable of a sensation, and while, even at that time, the results obtained were

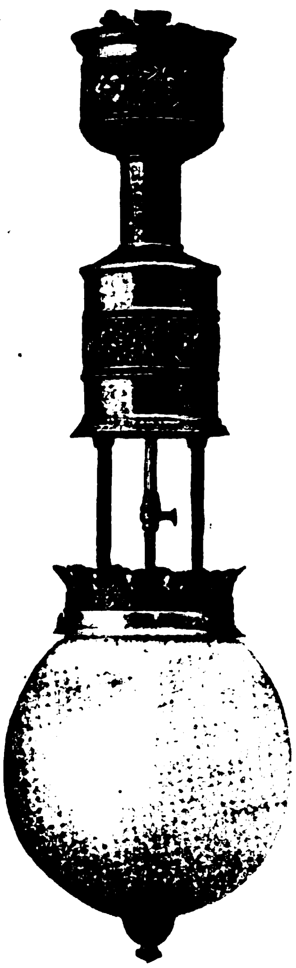


FIG. 1.
THE PIONEER STANDARD INDOOR LAMP.

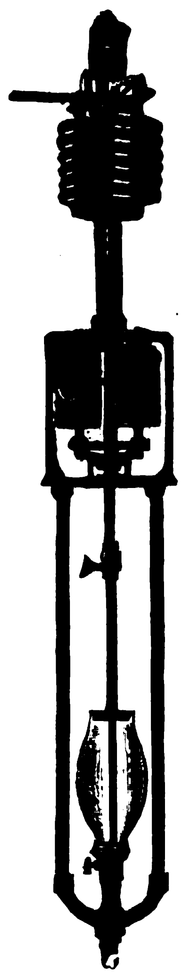


FIG. 2.
PIONEER LAMP WITH CASE AND GLOBE REMOVED.

remarkable in their way, the improvements which have since been effected by Mr. Marks are such that the inclosed arc lamp now occupies a position of established reputation in the field of illumination. That this statement is fully warranted must be conceded when we state that nearly one thousand of the "Pioneer" inclosed arc lamps, as the Marks lamp is called, will be installed in the great New York department store of the Siegel-Cooper Company, now rapidly nearing completion. The selection of the Pioneer inclosed arc lamp was by no means a matter of chance, but was decided upon after a competitive test with nearly every other arc lamp in the market.

The improvements which have been effected will be apparent by a glance at the accompanying illustrations. In these, Fig. 1 shows an outside view of the Pioneer standard indoor lamp, while Figs. 2 and 3 show the interior with the case removed, and also an enlarged detail of the mechanism; the latter, it will be noted, is extremely simple in character, consisting merely of a pair of solenoid magnets bearing the clutch mechanism; no springs or auxiliary mechanism of any kind being employed.

The features which make the Pioneer arc lamp particularly valuable are: First, that the lamps require trimming at intervals of only ten days, or two weeks, while in some situations with short hours of burning a monthly trimming only would be necessary. The lamp does not require cored carbons, the ordinary solid carbons being used. This results not only in a saving on the cost of carbons, but also in that of trimming—items which, together, aggregate a saving of from fifteen to twenty dollars per year per lamp.

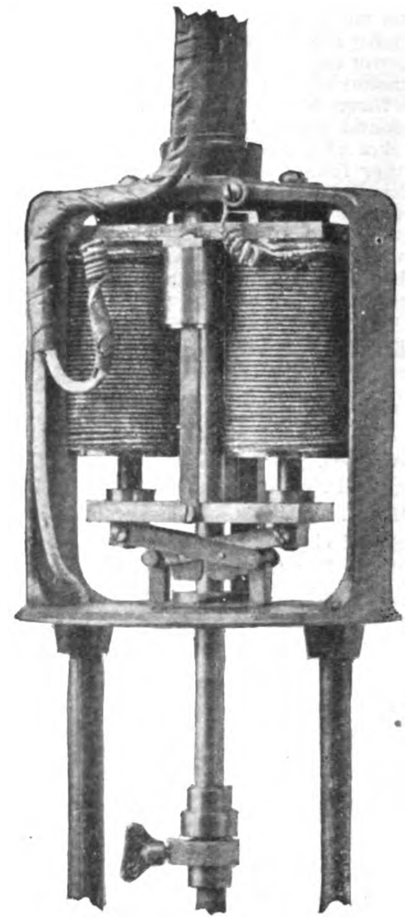


FIG. 3.—THE PIONEER LAMP MECHANISM.

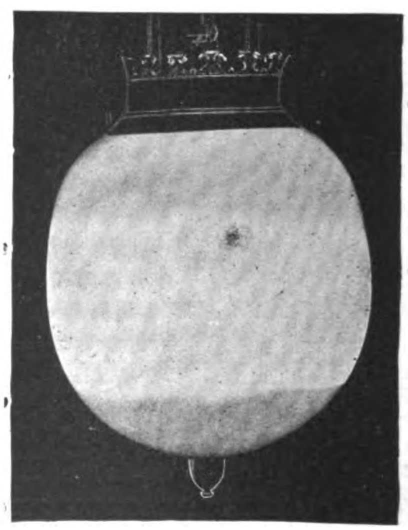


FIG. 4.—SHADOWS ON GLOBE OF OLD STYLE LAMP.

Owing to the arc being inclosed, it is possible to run the lamp on incandescent circuits at a much higher potential than

where the arc is not inclosed, so that the Pioneer lamp can be run singly, each lamp independent of the other. It follows from this also that one lamp cannot rob the other of light, as is frequently the case where two are run in series. As regards distribution of light, which is an essential factor, both in outdoor and indoor lighting, the inclosed arc has a decided advantage over the open air arc. This is well illustrated in Figs. 4 and 5. Thus, Fig. 4 is a direct reproduction from a

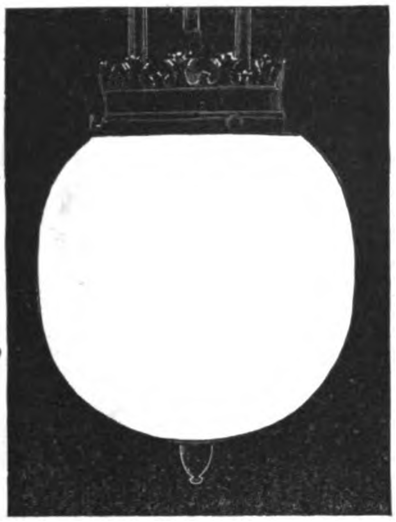


FIG. 5.—SHADOWLESS GLOBE OF THE PIONEER LAMP.

photograph of an open air arc lamp, showing the shadows cast by the carbons, while Fig. 5 is a photograph of the Pioneer inclosed arc lamp, showing a remarkably even distribution of light. This quality of the lamp will be especially appreciated by storekeepers and factory owners, as it avoids one of the greatest inconveniences attached to the old form of arc lamp.

Not the least important advantage of the inclosed arc is its perfect cleanliness, since all the carbon dust is completely consumed, and, above all, its perfect qualities as a spark arrester. This has an important bearing on the insurance question, and the lamp on this account has been thoroughly indorsed by the fire underwriters.

The Electric Arc Light Co., manufacturers of the Pioneer arc lamp, have secured a fine suite of offices and salesrooms at 687-689 Broadway, and agencies are being established in every important city in the Union.

NOTES ON CONCENTRIC WIRING.

BY C. J. KINTNER.

I HAVE read with very much interest the paper of Mr. Sam Mavor on "Concentric Wiring," published in the January issues of "The Electrical Engineer" and referred to in numerous other electrical journals at various times since its publication. To the question of concentric wiring, I gave much attention, as early as 1886, when the induction system of electric lighting of Gaulard & Gibbs was introduced into this country by Mr. Westinghouse, it being obvious to me at that time that with a high tension system of primary currents, a protective system of wiring would be necessary. I have written a number of articles touching, and taken a number of patents covering broadly, the principle of concentric wiring wherein the inner conductor is removable from the outer or concentric conductor, and have made various improvements in concentric safety or protective devices for use in connection therewith.

Although Mr. Mavor has pointed out very clearly many of the advantages of the concentric system over existing systems of wiring, and also the fact that such a system is much safer than is possible with a two-wire system, there are other important advantages which he has failed to note and to which I desire to direct attention if you will grant me the space in your valuable paper at this time.

First, he has failed to note that oftentimes with existing systems of wiring in which lead cables are used, the cables are ruptured; and no one, so far as I know, has yet satisfactorily explained the reason of such rupture. It is undoubtedly due to high statical charges upon the cables during thunderstorms, or, at times when atmospheric electricity is conveyed to said cables from the surface conductors, the high static charge undoubtedly penetrating the cables and therefore effectually ruining them.

Second, no one has yet, so far as I am aware, satisfactorily accounted for the explosions in manholes and subways where electric wires are found. Such explosions are undoubtedly due to the presence of electric wires, as they were, so far as I am aware, unknown or certainly of very rare occurrence before wires were placed in the subways. Although these explosions have been attributed to leaking gas from gas mains ignited by the presence of an arc from subway conductors, or to the generation of explosive gases through the electrolytic action of metals with which the cables are armored, I am convinced that most of these theories in this direction are absolutely incorrect, and that such explosions are really due to the presence of atmospherical electricity conveyed to the subways by the surface conductors, and I base my conviction in this direction upon the fact that all the subway explosions I have ever heard of have occurred in the summer time, or at that period of the year when atmospheric electricity is prevalent. If any one of the readers of this article is aware of any such explosion at a time other than during the season when exterior or atmospheric currents are liable to find their way to the subways, I should be pleased to hear of it.

It is also a matter of common knowledge that persons often receive marked shocks from incandescent globes connected with existing systems of electric lighting; such shocks, I may add, as are not possibly attributable to currents of the voltage used at the lamps. They can therefore only be attributable to atmospheric charges which do not find their way to earth through the absolutely perfectly insulated systems of lighting as now used in this country. With a perfect system of concentric wiring having absolutely earthed contact at all points for the outer conductor, no safer system of lighting or transmission of power can possibly be imagined, so that all of the bugaboo raised by the insurance companies and those who oppose the earthing of the third wire in the Edison system is in in fact fallacious, provided, of course, that such third wire be inclosed in a concentric conductor, which is properly earthed.

The English people are far in advance of us in the matter of the use of concentric wiring, and Mr. Mavor in his able article, so clearly points out how perfectly such a system works, even with the poorest kind of insulation, that it seems to me engineers in this country are standing in their own light in not freely acknowledging the advisability of the use of this type of conductors.

A NEW METHOD OF STUDYING THE LIGHT OF ALTERNATING ARC LAMPS.[1]

BY W. L. PUFFER.

THE author first referred to the general characteristics of the continuous current arc. To demonstrate the properties of the arc the latter was thrown on a screen and observed by the stroboscopic method by means of a revolving disc, with slots cut in it, and revolved so as to intercept the rays from the arc at definite periods.

The experiments clearly show that the alternating current arc is a sequence of direct current arcs, alternating in polarity, and that each wave of current produces very clearly and distinctly all the attributes of the direct current arc.

In subsequent experiments with a synchronous alternating motor, a disc was used having half as many slots as there were pole pieces on the dynamo. With 500 volts, and a large non-inductive resistance in series with the arc, it was plainly evident that the current wave was approximately sinusoidal, as the time of extinction of the current, as indicated by the blue band of the arc proper, was very short, and the rise and fall of the current gradual, and with no irregularities. This was to be expected, as the back e. m. f. of the arc is small compared to the voltage of the generator, and the circuit as a whole is non-inductive.

The opposite condition was realized by using a lower e. m. f. and regulating by a reactive coil. The time of no current was longer, and the current appeared to jump to its maximum in an exceedingly small angular time. In this case the arc was not steady, showing clearly to the eye that the succeeding waves of current were not alike either in form or current value, and also that the angle of lag was constantly changing. This fact has always prevented an accurate plotting of wave forms by the instantaneous contact method, and, although known to exist, was never before actually seen.

A very pretty double arc was arranged by using three carbons and wiring two circuits, each with current regulators, in such a way that the arc was the common junction, and one

[1]Abstract of a paper read before the American Institute of Electrical Engineers, March 25, 1896.

carbon was of one polarity, while the other two were of opposite polarity. With wire resistances in each side, there was nothing peculiar to be noted other than the effects of the junction of two currents, but when the resistance in one circuit was gradually cut out, and equivalent inductance cut in, there was at once visible evidence of the lag of the current, together with the change of shape of the wave and the unsteadiness before noted. Owing to the long time of no current in the inductive side there were times when even with considerable lag there were actually no visible traces of current between either points.

In this way there have been studied single arcs of high and low e. m. f., long and short double arcs, arcs with much inductance in circuit, Jablochkoff candles, arc between a ring and a point within, the spinning arc between the ends of a carbon cylinder and a concentric carbon within, with a magnetizing coil around the inner carbon and the like.

One of the most beautiful arcs investigated visually and photographically was a rotary arc made by the use of three carbons in the same plane, at angles of 120° apart and wired up as the junction point of an external Y load on a 500-volt 60 cycle three-phase generator. Non-inductive resistance was used in the circuit, and the current used in one leg of the Y was 10 or 15 amperes.

The three-phase arc is less noisy than the single phase, and its light is steadier and has less variation in its total intensity, owing to the fact that the current never stops, and there is always a positive carbon. Three cored carbons, placed parallel side by side, with slight magnetizing coils to keep the arc at the ends of the carbon, will give a very satisfactory light in the direction away from the tips, and may be used when it is desirable to throw the light all in one direction.

Four carbons at 90° apart, each with a suitable resistance in series with it, and connected to quarter-phase tap wires on a Gramme ring or other generator giving quarter-phase circuits, will also produce a rotary field arc of great beauty and interest. Prof. Puffer is continuing these experiments.

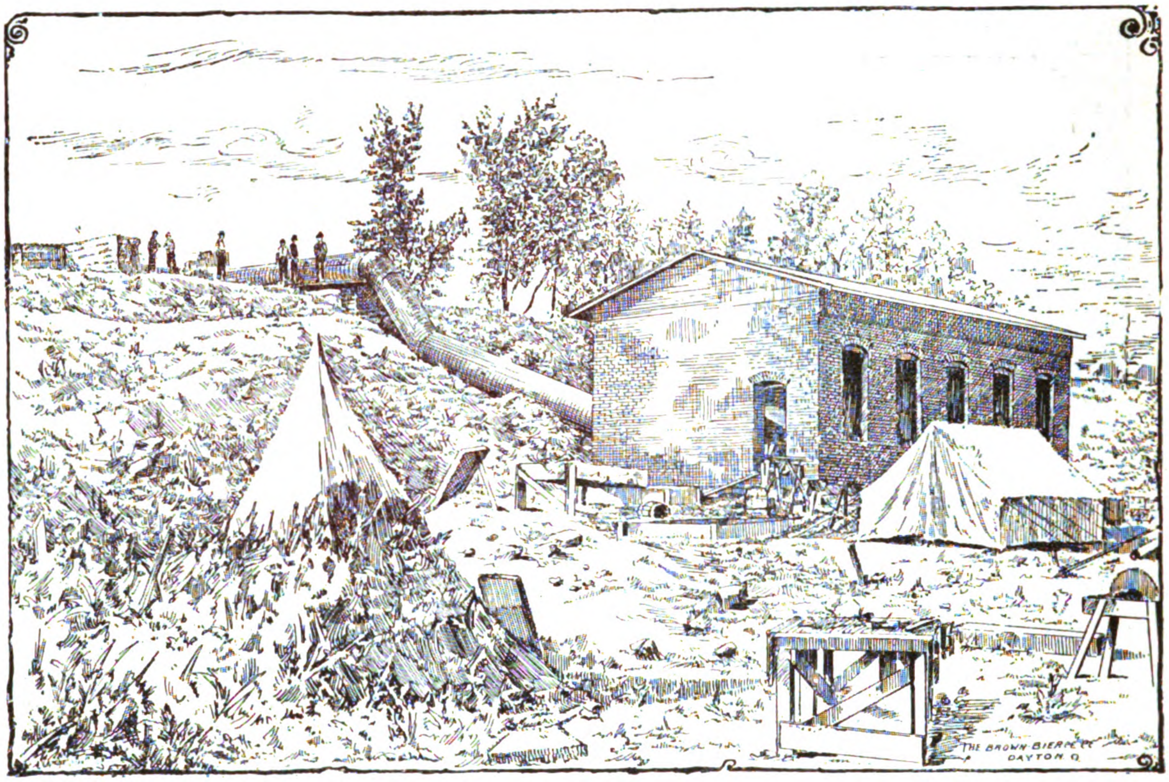
MUNICIPAL PLANT FOR RIVERSIDE, CAL.

Mr. Geo. A. Johnston informs us that the contract for the Riverside, Cal., municipal lighting plant is now being carried out by the California Electrical Works, of San Francisco, who furnish all the labor and material. This includes a 21-mile, 10,000-volt transmission line, as well as the city mains. For lighting, 100 Helios alternating arcs will be used. The transformers will all be of Helios make. The price is $40,978.

POWER TRANSMISSION.

A NOVEL IRRIGATING AND ELECTRIC PLANT AT MESA, ARIZONA.

THE cut herewith illustrates a special water power plant constructed by the Stilwell-Bierce & Smith-Vaile Company, Dayton, O., for the Consolidated Canal Company, Mesa, Ariz. The water is taken from the Salt River and carried by a 48-inch feed pipe across the Utah Canal to a pair of 21-inch cylinder gate Victor turbines on a horizontal shaft, developing 400 horse-power under 40 feet head. One end of the shaft is connected by a friction clutch to a 200-horse-power dynamo, which furnishes light and power for the town of Mesa, Ariz. The other end of the shaft is connected to a pumping plant for irrigating purposes. This novel station is suggestive of great possibilities in this line.



ELECTRICAL AND IRRIGATING PLANT IN ARIZONA.

THE WELLAND POWER & SUPPLY CANAL COMPANY LTD.

The Welland Power and Supply Canal Company, Limited, was incorporated under special act of the Dominion of Canada in 1894, for the purpose of utilizing the natural water supply of the Niagara and Welland Rivers, with the object of promoting manufacturing industries and inducing the establishment of manufactories and the development of general business. The company now propose to construct and operate a canal and hydraulic raceway from a point in the Welland River, within five miles of its mouth, across comparatively level land, to a point or points on the Niagara escarpment, with such enlargements of the natural watercourses in the townships of Grantham and Niagara, as may be necessary for carrying off the water from the power canal to Lake Ontario.

URBAN & CO., the great milling firm of Buffalo, issue a very handsome calendar to their many friends. This year it contains some excellent views of the Niagara power enterprise. Mr. George Urban has long been interested in electric light and power work, and his flour mills are one of the sights of the "new Chicago."

MR. JOHN B. WHITE has succeeded Mr. J. A. Wallace as superintendent of the Eastchester (N. Y.) Electric Light Co.

SOCIETY AND CLUB NOTES.

PRELIMINARY LIST OF EXHIBITORS AT THE ELECTRICAL EXPOSITION.

WE publish below a preliminary list of exhibitors at the National Electrical Exposition to be held in this city next May, and Mr. G. F. Porter, the secretary, states that another list nearly as large is in hand of exhibitors, who have reserved space, but whose contracts have not yet been signed. This absorbs the 36,000 square feet of space contracted for, and the Exposition Company has already deemed it advisable to contract for another 10,000 square feet of space equally desirable. Details of many features of interest are promised for early publication. The partial list given below is strikingly representative:

LIST OF EXHIBITORS.

A. A. McCreary, New York.
Abendroth & Root Co., New York.
Adams-Bagnall Electric Co., Cleveland, O.
American Carbon Co., Noblesville, Ind.
American Stoker Co., Dayton, O.
Babcock & Wilcox Co., New York.
Ball & Wood Co., New York.
Bishop Gutta Percha Co., New York.
Birdsall Electric Manufacturing Co., New York City.
Bryant Electric Co., Bridgeport, Conn.
Brady, T. H., New Britain, Conn.
Bradford Belting Co., Cincinnati, O.
Bryan-Marsh Electric Co., New York.
Bossert, Wm. F., New York.
Burry, John, New York.
Card Electric Motor & Dynamo Co., Cincinnati, O.
Carpenter Enamel Rheostat Co., Hoboken, N. J.
Calculagraph Co., New York.
Clark Electric Co., New York.
Columbia Incandescent Lamp Co., St. Louis, Mo.
Corey, R. B., New York.
Chapin-Douglass Electric Co., New York.
Cutter Electrical Manufacturing Co., Philadelphia, Pa.
Crocker-Wheeler Electric Co., New York.
Columbia Rubber Works Co., New York.
Crouse-Tremaine Carbon Co., Fostoria, O.
Crane Co., New York.
Diehl Manufacturing Co., Elizabethport, N. J.
Dale, Farrell & Co., New York.
Eddy Electric Manufacturing Co., Windsor, Conn.
Edison Electric Illuminating Co., New York.
Electric Storage Battery Co., Philadelphia, Pa.
"Electrical Engineer," New York.
Electricity Newspaper Co., New York.
Forest City Electric Co., Cleveland, O.
Ferracute Machine Co., Bridgeton, N. J.
Fuel Economizer Co., Matteawan, N. Y.
Goubert Manufacturing Co., New York.
General Electric Co., Schenectady, N. Y.
Gordon-Burnham Battery Co., New York.
General Incandescent Arc Light Co., New York.
Harrisburg Foundry and Machine Co., Harrisburg, Pa.
Huebel & Manger, Brooklyn, N. Y.
Holtzer-Cabot Electric Co., Boston, Mass.
Heine Safety Boiler Co., St. Louis, Mo.
Hunt, C. W., Co., New York.
Ironclad Rheostat Co., Westfield, N. J.
India Rubber and Gutta Percha Insulating Co., Yonkers, N. Y.
Jewell Belting Co., Hartford, Conn.
Johnston, W. J., Co., New York.
Keasbey, R. A., New York.
Kennedy Valve Co., New York.
Keuffel & Esser Co., New York.
Lozier, R. T., New York.
Locke Regulator Co., New York.
L. Katzenstein, New York.
Mica Insulator Co., New York.
McEwen, J. J., Manufacturing Co., Ridgeway, Pa.
National Carbon Co., Cleveland, O.
National Conduit Manufacturing Co., New York.
New York & Ohio Co., Warren, O.
Nowotney Electric Co., Cincinnati, O.
Nuttall, R. D., Co., Allegheny, Pa.
Niles Tool Works Co., Hamilton, O.
Okonite Co., New York.
Phoenix Iron Works, Meadville, Pa.
Peck Electrical Co., New York.
Partrick & Carter Co., Philadelphia, Pa.
Peru Electric Manufacturing Co., Peru, Ind.
Payne, B. W., & Sons, Elmira, N. Y.
Proctor-Raymond Co., Buffalo, N. Y.
Reisinger, Hugo, New York.
Riker Electric Motor Co., Brooklyn, N. Y.
Roebling's Sons, John A., Co., New York.
Russell & See, New York.
Stirling Co., Chicago, Ill.
Schieren, Chas. A., & Co., New York.
Siemens & Halske Electric Co. of America, Chicago, Ill.
Sunbeam Incandescent Lamp Co., Chicago, Ill.
Straight Line Engine Co., Syracuse, N. Y.
Standard Electrical Lamp and Novelty Co., New York.
Standard Paint Co., New York.
Standard Underground Cable Co., Pittsburg, Pa.
Shultz Belting Co., St. Louis, Mo.
Stanley Electrical Manufacturing Co., Pittsfield, Mass.
Safety Insulated Wire and Cable Co., New York.
Stanley & Patterson, New York.
Schoonmaker, A. V., New York.
Smeltzer & Co., Nurnberg, Bavaria.
Straight Line Engine Co., Syracuse, N. Y.
The E. T. Burrowes Co., Portland, Me.
Tucker Electrical Construction Co., New York.
United Electric Improvement Co., Philadelphia, Pa.
United States Mineral Wool Co., New York.
Vacuum Oil Co., New York.
Vetter, J. C., & Co., New York.
Walker Manufacturing Co., Cleveland, O.
Warren, A. K., & Co., New York.
Wagner Electrical Manufacturing Co., St. Louis, Mo.
Weston Engine Co., Painted Post, N. Y.
Weston Electrical Instrument Co., Newark, N. J.
Williamsport Wooden Pipe Co., Williamsport, Pa.
Worthington, Henry R., New York.
Wilkinson Manufacturing Co., Bridgeport, Pa.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—NOMINATIONS FOR OFFICES.

AT the monthly meeting of council held March 25, the returns of nominations were canvassed and the following council nominees were selected: For president, Louis Duncan, of Baltimore; for vice-presidents, Charles P. Steinmetz, of Schenectady, N. Y.; Harris J. Ryan, of Ithaca, N. Y., and W. M. Stine, of Chicago; for managers, J. W. Lieb, Jr., of New York City; F. A. Pickernell, of New York City; Wm. L. Puffer, of Boston,j and L. B. Stillwell, of Pittsburg; for treasurer, George A. Hamilton, of New York City; for secretary, Ralph W. Pope, of New York City.

The terms of the following officers do not expire this year: Vice-presidents Angus S. Hibbard, Dr. M. I. Pupin and W. F. C. Hasson; managers, A. E. Kennelly, C. S. Bradley, W. D. Weaver, W. B. Vansize, Charles F. Scott, Carl Hering, Cary T. Hutchinson and B. J. Arnold.

The rules have been amended by the council under advice of the Committee on Incorporation, in order to conform with the laws of the State of New York. The rules will hereafter be known as the "Constitution," and under its provisions the secretary is now elected by the Institute at large, instead of by the council. The system of cumulative voting is abolished. Copies of the revised constitution will be mailed to the membership with the ballots on or before April 15.

The following associate members were elected:

Philander Betts (3d), electrician, U. S. Navy Yard, Washington, D. C.; Charles Frederick Burgess, instructor in Electrical Engineering, University of Wisconsin, Madison, Wis.; A. Wright Chapman, electrical engineer, Fort Wayne Electrical Corporation, Baltimore, Md.; Wm. Edgar Firth, chief engineer, the Midvale Steel Co., Nicetown, Philadelphia; Frank R. Ford, M. E., consulting engineer, Ford & Bacon, 203 Broadway, New York City; Lucius T. Gibbs, manager and chief engineer, Gibbs Electric Co., Milwaukee, Wis.; Ch. Gorrissen, superintendent, Fort Wayne Electrical Corporation, Baltimore, Md.; Elwin Clinton Green, testing department and installing work, Jenney Electric Motor Co., Indianapolis, Ind.; Arthur A. Hamerschlag, electrical expert and owner, Hamerschlag & Co., 26 Liberty street, New York City; Wm. S. Hulse, electrical engineer, Fort Wayne Electrical Corporation, Baltimore, Md.; Arthur De La M. Lozier, M. E., salesman and expert, Westinghouse, Church, Kerr & Co., 26 Cortlandt street, New York City; Frederick Mackintosh, electrical engineer, General Electrical Co., residence, 9 South Church street, Schenectady, N. Y.; James W. Manson, wire chief, Franklin Street Exchange, Met. Tel. and Tel. Co.; Wm. J. Phelps, electrical engineer and contractor, Box 272, Asheville,

N. C., residence, Chicago, Ill.; H. Hobart Porter, Jr., agent, Westinghouse Electrical and Manufacturing Co., 120 Broadway, New York; Taylor William Ross, second assistant engineer, U.S. Revenue Cutter "McLane," Key West, Fla.; Howard R. Sargent, electrical engineer, General Electric Co., residence, 510 Union street, Schenectady, N. Y.; W. M. Stewart, wire chief, Met. Tel. & Tel. Co., 18 Cortlandt street, New York City; Howard F. Thurber, general superintendent, Met. Tel. & Tel. Co., 18 Cortlandt street, New York City.

At the meeting of the institute in the evening a paper was presented by Prof. W. L. Puffer, of Boston, on "A New Method of Studying the Light of Alternating Arcs." Sixty members and visitors were present. After the reading of the paper the meeting adjourned to Columbia University, where the experiments referred to were very effectively shown on a screen.

ELECTRICITY AS AN EXACT SCIENCE.

PROFESSOR FRANCIS B. CROCKER lectured before the Franklin Institute on March 20, on the above subject. The hackneyed expression that "electrical science is only in its infancy" was very vigorously denied by the lecturer. The remark recently published that "in a department of knowledge, whose principles are yet obscure, any moment may give birth to a fact revolutionary in its consequences," was regarded by Professor Crocker as a libel upon the profession of electrical engineering. A serious obstacle in the path of the electrical engineer is the general opinion that electrical science is a happy guesswork, and that its greatest engineers and inventors are peculiar geniuses or fortunate blunderers, who have stumbled on certain results without mental or other processes.

As a matter of fact, he said, electricity, as a science, is one of the most exact of the known sciences and second only to astronomy. The most important test of a science is the power of prediction. Upon that test astronomy stands pre-eminent, yet so exact is electrical science that the economy of the operation of a dynamo or motor can to-day be calculated from the drawings, before the machine is built, more nearly than by a test made of the machine itself. No one could assert the same of a steam engine or any other machine not extremely simple. In electrical engineering the uncertain quantities are mechanical ones, the friction of a belt, of a bearing, of the air resistance. But the calculation of the electro-motive force and current generated by the dynamo, the current consumed in the field, the Foucault currents in the armature and similar losses, are all the subject of exact mathematical calculation; the only doubtful elements would be mechanical.

The great names connected with electrical science are in themselves most powerful arguments in favor of its definiteness—Franklin, Faraday, Lord Kelvin, Maxwell and many of the most distinguished names that science has ever had, who were physicists before they were electricians. These names are not connected with indefiniteness of ideas; they are intellectual giants of the first magnitude. The rapid progress of electrical science is an argument in favor of its exactness. The entire development of electrical engineering has taken place within the last twenty years. In 1876 the telephone was first heard of; electric lighting came in 1878-9; electric metallurgy has received nearly all its development within that period. These permanent results would not have been possible with an inexact science.

The most surprising results to the popular mind are doubtless those attained in telephony, where conversation is carried on between Boston and Chicago. The transmission of 100 horse-power for a distance of more than 100 miles between Frankfort and Lauffen in 1891, with an efficiency of 75 per cent., has shown the world what can be done. The absolute calculations which are possible to the electrical engineer show that it is perfectly feasible to transmit power to even greater distances, and also to fix a limit to the economy of such transmission. The transmission of several messages over a single wire in opposite directions, or in the same direction and at the same time, is another of the great inventions of the brief period referred to. Yet these inventions were not stumbled upon, but were carefully worked out by the exact laws of electrical science. The construction of the great 5,000-horse-power dynamos which now utilize the power of Niagara was not a working in the dark. The great Corliss engine, the wonder of the Centennial Exposition of 1876, had but one-fifth the power of one of these dynamos, yet every part was accurately calculated. The first great machine was never tested until it was put in the place where it was to stand, and it was found to fulfill every expectation. No power machine of any nature of so great capacity was ever before constructed. It involved principles and constructive features that had never before been attempted, yet worked perfectly.

The fact which gives electrical science its exactness is the correctness with which electrical measurements can be made with the voltmeter and the ammeter. They are extremly accurate instruments, correct within 1 per cent.—can be used without stopping the machinery, and a test be made in a few seconds, which will determine the conditions of the circuit, and bring one face to face with the facts. No other power can be thus measured. The ability to test with such exactness is the foundation stone of the science.

THE FLUOROSCOPE AT THE NEW YORK ACADEMY OF SCIENCES.

THERE was quite a flutter among the ladies of the audience at the annual reception of the Academy of Sciences in the American Museum of Natural History on the evening of the 26th ult. Prof. Pupin gave a very interesting lecture, and, after pointing out the various steps leading up to Röntgen's discovery, and explaining the apparatus used in producing the X-rays, gave an exhibition of the capabilities of the fluoroscope. An uncanny atmosphere crept into the room as Prof. Pupin declared that he could see the skeleton of his own hand perfectly. After a while the audience took courage, and a number of them took advantage of the opportunity to look at their own phalanges, and were convinced. One woman feared she could not see the bones through her black glove, but she did see them and then hurried away. Prof. Pupin suggested that, instead of the "fluoroscope," the screen which has been made susceptible to the Röntgen radiance by a coating of the salt tungstate of calcium, should be called a "phosphoroscope," since the screen retains its luminosity some time after the passage of the X-rays has been cut off.

Although Prof. Pupin's lecture formed the most interesting feature of the evening reception, yet the many interesting exhibits of the latest development in science attracted much attention. In the electrical field the most noticeable exhibit was that of Prof. Pupin's apparatus for conducting X-ray experiments. In an alcove was shown in operation an instantaneous contact-maker attached to a 4-frequency alternator, driven by a small electric motor. A series of necessary measuring apparatus, including dynamometers, Kelvin multicellular voltmeter, transformers, etc., were all shown in circuit. Prof. Pupin also showed a motor transformer with current interrupter and a large number of interesting Röntgengraphs.

In addition to Prof. Pupin's exhibit, a very interesting series of Röntgengraphs were shown by various experimenters, notably one of a man's foot in his boot, taken by Nikola Tesla, showing in faint outlines the trousers, flesh, shape of the foot, and revealing distinctly the skeleton of the foot, the nails in the heel of the boot, and the eyelets and hooks for the laces.

A very interesting series of photographs of lightning were also shown, and a quantity of recent physical apparatus for electrical experiments.

N. E. L. A. TRANSPORTATION.

MR. C. O. BAKER, JR., Master of Transportation of the National Electric Light Association, reports as follows:

I am pleased to inform you that the Central Passenger Committee have granted the rate of a fare and one-third, on the certificate plan, from points in their territory to New York and return, for delegates attending the nineteenth convention of this association.

Mr. W. A. Kreidler, of the "Western Electrician," Chicago; Messrs. Bryan and Humphrey, Turner Building, St. Louis, and E. H. Heinrichs, of the Westinghouse Electric and Manufacturing Company, Pittsburg, will have charge of transportation matters in their respective localities.

A special party is being organized in Chicago, which will be joined en route by delegates along the line. A very large attendance is anticipated.

THE ASSOCIATION OF MISSOURI COMPANIES.

A special dispatch from Sedalia, Mo., of March 18, says: The Associated Water, Gas and Electric Light Companies of Missouri began their annual meeting here this afternoon, and will remain in session over to-morrow. In the absence of President W. E. Walton, of Butler, James A. Montgomery, of Sedalia, vice-president, called the meeting to order, and C. F. Strohm, of Nevada, officiated as secretary.

Considerable routine business was transacted, after which the following officers were elected for the ensuing year: Jas. A. Montgomery, Sedalia, president, R. D. Wirt, Independence, vice-president; C. F. Strohm, Nevada, secretary; Charles Carroll, Sedalia, treasurer.

The Executive Committee consists of the president, vice-president, and secretary, and F. J. Tygard, of Butler, and J. H. Shelton, of Clinton.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS, ISSUED MARCH 17, 1896.

Alarms and Signals:—

PNEUMATIC SIGNALING DEVICE. S. P. Hull and J. H. Boylett, Poughkeepsie, N. Y., 556,577. Filed Jan. 9, 1895.
Semaphore is operated by a piston controlled by electromagnets and means are provided whereby a pump is operated by passing trains to store the air.

BLOCK SIGNAL TELEGRAPH. C. M. Grace, Philadelphia, Pa., 556,070. Filed Sept. 10, 1895.
Is operated by a dynamo current proceeding from a single generator, each station being adapted to draw current from a common feed-wire and signal on either or both sides of a line wire.

Batteries:—

BATTERY CONNECTION. M. M. Kohn, Chicago, Ill., 556,544. Filed July 29, 1895.
The battery is mounted upon the same support or base board that carries the translating device.

SECONDARY VOLTAIC BATTERY. W. A. B. Buckland, London, England, 556,660. Filed July 15, 1895.
The active material is held in position on the plate without exposing any of the plate to the action of the electrolyte.

PORTABLE FARADIC BATTERY. J. E. Unger, New York, 556,708. Filed Feb. 6, 1896.
The exterior casing of the battery forms the electrodes and serves as an inclosure for a so-called "dry battery" and the induction coil.

Distribution:—

SYSTEM OF MULTIPHASE DISTRIBUTION. R. D. Mershon, Pittsburg, Pa., 556,359. Filed April 11, 1895.
For description see page 312, last issue.

Lamps and Appurtenances:—

ELECTRICAL CONNECTOR FOR ARC LIGHTS. J. J. McGill, Thorold, Canada, 556,362. Filed Jan. 15, 1896.
A ball and socket metal connection between the end of the loop wire leading to the lamp and the wire carried by the insulator leading from the line.

ELECTRIC ARC LAMP. G. C. Pyle, Indianapolis, Ind., 556,437. Filed May 2, 1895.
Designed especially for use in electric headlights.

ELECTRIC ARC LAMP. T. Spencer, Philadelphia, Pa., 556,479. Filed July 1, 1895.
Consists of a frictional feed regulator, a magnet controlling the same, and regulating the length of the arc and an independent stopping device for limiting the extent of slip of the friction mechanism.

ELECTRIC LAMP. C. E. Quimby, New York, 556,693. Filed Aug. 18, 1893.
A metallic shield incloses one-half of the lamp and extends through the central aperture of the lamp beyond the plane of the annular illuminating conductor, and a heat insulating backing is applied to the metallic shield.

Miscellaneous:—

ELECTRICAL GAS COCK. H. L. Taylor, Corning, N. Y., 556,386. Filed June 20, 1895.
The valve is operated by an electromagnet.

ELECTRIC HUB WELDING MACHINE. C. E. Hartman, Lynn, Mass., 556,414. Filed June 20, 1891.
Two work-electrodes adapted to squeeze or compress the work between them.

ELECTRICAL REGISTERING INSTRUMENT. H. Lemp, Lynn, Mass., 556,425. Filed March 12, 1891.
An actuating electromagnet having an iron core and coil related so that the iron of the core will saturate with a very small fraction of the maximum current employed in operating the register. Intended for welding machines.

ELECTRIC METAL WORKING APPARATUS. H. Lemp and W. B. Lewis, Lynn, Mass., 556,426. Filed April 23, 1891.
A single work holder forming a pole of the heating source is surrounded by a number of independently movable work holders, also connected with the source and provided with independent automatic cut-off devices.

ELECTRIC PROGRAM CLOCK. J. P. Luxmore, Chicago, Ill., 556,428. Filed Nov. 14, 1894.

ELECTRIC ELEVATOR. J. J. Parkinson, T. M. Martin and C. C. Bowen, Los Angeles, Cal., 556,435. Filed Feb. 7, 1895.
Details of construction.

ELECTRIC DRILL. M. Hebgen, Butte, Mont., 556,502. Filed July 16, 1895.
The armature is mounted on a hollow shaft through which extends the drill shaft, which is capable of longitudinal motion, that it may be fed forward to advance drill or be retracted.

ELECTRIC HEATER. J. E. Williamson, C. E. Collins and J. B. Graham, Allegheny, Pa., 556,524. Filed Feb. 9, 1894.
Details of construction.

ELECTRO-THERAPEUTIC APPARATUS. W. Carter, Louisville, Ky., 556,617. Filed Jan. 29, 1896.
Provides a motor generator capable of generating a direct and alternating current simultaneously.

ELECTRIC FURNACE. A. C. Girard and E. A. G. Street, Paris, France, 556,626. Filed May 24, 1895.
A heated chamber with electrode projecting into it, a passageway through chamber capable of receiving the object to be heated and means for producing a voltaic arc between said electrode and the object to be heated.

ELECTRIC FURNACE. A. C. Girard and E. A. G. Street, Paris, France, 556,626. Filed May 24, 1895.
A heated chamber with electrode projecting into it, a passageway through chamber capable of receiving the object to be heated and means for producing a voltaic arc between said electrode and the object to be heated.

DEVICE FOR DETECTING SHORT CIRCUITS. C. F. Scott, Pittsburg, Pa., and C. E. Skinner, Allegheny, Pa., 556,646. Filed Dec. 31, 1892.
Consists in varying the number of lines of force passing through a coil and determining whether or not said coil is heated thereby.

PROCESS OF EXTRACTING GOLD FROM SOLUTIONS. G. O. Pearce, Colorado City, Colo., 556,690. Filed May 8, 1895.
Consists in passing said solution through a mass of vegetable carbon having associated with it sulphate of iron, oxalic acid and tartaric acid.

ELECTRICAL APPARATUS FOR DRILLING WELLS, TUNNELS, ETC. P. Semmer, Irwin, Pa., 556,718. Filed Aug. 16, 1895.
Employs a motor contained within a casing, the drill being mounted on the lengthened armature shaft of said motor.

Railways and Appliances:—

MOTOR SUSPENSION. N. C. Bassett, Lynn, Mass., 556,488. Filed Nov. 27, 1895.
One end of motor is geared to axle and the other to a bar on yoke supported by the truck frame at substantially the plane of the center of gravity of the motor.

ELECTRIC RAILWAY SYSTEM. B. E. Osborn, Auburn, N. Y., 556,516. Filed Sept. 3, 1895.
Embodies a switching device for connecting the feeding conductor to the working conductors.

RAILROAD CROSSING SIGNAL. R. O'Toole, Thurmont, Md., 556,553. Filed Feb. 20, 1895.
So constructed that a signal will be given when the train is approaching the crossing, but not when it is passing away from the crossing.

UNDERGROUND CONDUCTOR FOR ELECTRIC RAILWAYS. G. Westinghouse, Jr., Pittsburg, Pa., 556,602. Filed Jan. 6, 1894.
Composed of two like halves fastened together by means of conducting devices and having adjacent contact faces separated by a clear space.

ELECTRIC LOCOMOTIVE. T. E. Adams, Cleveland, O., 556,654. Filed Sept. 5, 1894.
The motor is so suspended that the weight of the motor and parts carried thereby will be equally distributed at opposite sides of the suspending devices.

SAND-BOX FOR ELECTRIC OR OTHER CARS. C. H. Cox, Haverhill, Mass., 556,712. Filed Dec. 17, 1895.
A sand-box having an outlet, and means for closing it, a movable member of a chute and means for operating it, and an inclined end.

Switches, Cut-Outs, etc.

ELECTRIC MOTOR RHEOSTAT. T. J. Fay, New York, 556,342. Filed Dec. 12, 1895.
Adjacent to the rheostat frame and mounted eccentrically upon the same shaft is a series of contacting rings, suitably mounted upon a cylinder, and effectually insulated from each other by alternately disposed layers of mica.

RHEOSTAT. T. J. Fay, Brooklyn, N. Y., 556,408. Filed Dec. 10, 1895.
A controlling lever, an electromagnet, the lever being pivoted to one of the poles of the magnet, a spring arranged to swing the lever on its pivot, the magnet being included in two circuits adapted to oppositely magnetize its core.

ELECTRIC SWITCH. N. Marshall, Boston, Mass., 556,510. Filed Dec. 14, 1895.
Employs spring actuated pawls on locking devices, one of which is in engagement with the movable contact member when the other is in engagement with the co-operative contact member.

Telephones:—

TELEPHONE. C. F. Dunderdale, Chicago, Ill., 556,496. Filed May 24, 1895.
Details of construction relating to a granulated carbon transmitter.

TELEPHONE SWITCHBOARD. I. Anderson, Saginaw, Mich., 556,609. Filed July 8, 1895.
Details of construction whereby a central station is obviated.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS, ISSUED MARCH 24, 1896.

Accumulators:—

ELECTRODE FOR SECONDARY BATTERIES. O. Pirsch, Liege, Belgium, 556,769. Filed March 11, 1895.
Thin sheet lead provided on both faces with outwardly flaring tubular projections.

SECONDARY BATTERY. M. Sussmann, Neu-Ruppin, Germany, 556,782. Filed May 15, 1895.
Comprises a sheet metal conductive core and an active material consisting of a paste composed of a plumbic material and pumice-stone, and a solution of rubber.

Alarms and Signals:—

BLOCK SYSTEM FOR RAILWAYS. B. C. Rowell, Boston, Mass., 556,773. Filed Dec. 16, 1893.
Two opposed signal apparatuses; mechanism connecting them and keeping them always in opposed positions.

Batteries:—

ZINC SUPPORT FOR BATTERIES. H. J. Brewer, New York, 556,048. Filed June 9, 1894.
Employs two downwardly projecting arms engaging with the two sides of the spout of the jar.

CONDUCTOR FOR ELECTRICAL DECOMPOSING TANKS. J. Leith, St. Helen's, England, 556,854. Filed Nov. 20, 1895.
Stranded wires or strips, each strand individually connected to the anodes.

Conductors, Conduits and Insulators:—

ELECTRICAL CONNECTOR. B. L. Toquet, Westport, Conn., 557,037. Filed Dec. 28, 1895.
A tube for a joint for electrical conductors indented to form an internal central stop.

Distribution:—

CONVERTER OF FREQUENCY FOR ALTERNATING ELECTRIC CURRENTS. M. Hutin and M. Leblanc, Paris, France, 556,094. Filed March 13, 1894.
Consists in successively and continuously changing the points of line connection in either direction around a commutator apparatus.

ALTERNATING CURRENT SYSTEM. E. W. Rice, Jr., Swampscott, Mass., 556,865. Filed Jan. 24, 1894.
A three-phase generator, in which the different armature coils are wound with wire of different section corresponding to the strength of the current they are designed to generate.

Dynamos and Motors:—

WIRE GAUZE BRUSH FOR DYNAMOS OR MOTORS. A. B. Soar

and E. W. Collier, London, England, 556,870. Filed Dec. 7, 1895.
Superposed layers of corrugated wire gauze.
SUPPORT FOR FIELD MAGNET COILS. B. G. Lamme, Pittsburg, Pa., 556,891. Filed Sept. 4, 1895.
Comprises a body portion in one plane and integral flanges in planes perpendicular thereto.

Electrometallurgy:—

PROCESS OF AND APPARATUS FOR PRODUCING METALLIC COMPOUNDS BY ELECTRICITY. E. N. Dickerson, New York, 557,057. Filed June 5, 1895.
Method of producing calcic carbide by a process of continuous feeding of material between the arcing electrodes.

Lamps and Appurtenances:—

ELECTRIC ARC LAMP. G. C. Pyle, Indianapolis, Ind., 556,898. Filed May 2, 1895.
Especially intended for locomotive headlights.
ELECTRIC SIGNAL LAMP. A. F. Ward, Memphis, Tenn., 556,946. Filed June 21, 1895.
A dynamo, a hand-driven mechanism therefor, a folding mast and a signal lamp at the upper end of said mast.
MEANS FOR ATTACHING AND DETACHING ELECTRIC LAMPS. F. A. Butterfield, Detroit, Mich., 556,959. Filed June 1, 1895.
A gripping arrangement for removing lamps in inaccessible places.

Miscellaneous:—

ELECTRIC ELEVATOR. E. W. Rice, Jr., Schenectady, N. Y., 556,866. Filed April 2, 1890.
An electrodynamic machine constructed to operate as a motor in causing the car to ascend and be operated on a short circuit as a generator by the car in descending.
DEVICE FOR PLACING ELECTRIC BLASTING FUSES. R. H. Elliott, Birmingham, Ala., 556,882. Filed July 13, 1895.
The wires are only insulated by wound insulation for a short distance from the fuse, and are then held between superimposed slabs of wood.
THERMO-EXPLOSIVE CARTRIDGE. C. H. Rudd, Chicago, Ill., 556,901. Filed Dec. 26, 1893.
Augments violence of chemical combination of explosive substances by means of heat applied when the explosion is desired.
ELECTRICAL DETONATOR. C. H. Rudd, Chicago, Ill., 556,902. Filed Feb. 3, 1894.
Relates to above.
ELECTRICAL DETONATOR. C. H. Rudd, Chicago, Ill., 556,903. Filed Feb. 3, 1894.
Relates to above.
ELECTRICAL DETONATOR. C. H. Rudd, Chicago, Ill., 556,904. Filed Feb. 3, 1894.
Relates to above.
ELECTRIC RECORDING INSTRUMENT FOR SHIPS' COMPASSES AND LOGS. C. L. Jaeger, Maywood, N. J., 556,987. Filed Jan. 25, 1894.
A conducting disc having projections, a conducting arm actuated through suitable mechanism and arranged to rotate close to the conducting disc, an induction coil and a recording device.
LIGHTNING ROD BALL. E. K. Hum, Pittsburg, Pa., 556,984. Filed Jan. 5, 1895.
Of silvered glass, having an interior coating of asphaltum or paint.

Railways and Appliances:—

TROLLEY SUPPORT. E. B. W. Reichel, Gross-Lichterfelde, Germany, 556,864. Filed Sept. 3, 1895.
Relates to a trolley base.
CLIP FOR TROLLEY WIRES. R. H. Beach, East Orange, N. J., 556,876. Filed April 17, 1895.
Comprises pivoted clamping members adapted to engage and hold the trolley wire.
ELECTRIC CAR TRUCK. E. Lundqvist, Pittsburg, Pa., 556,893. Filed July 31, 1895.
The motor is supported entirely upon the truck frame.
TROLLEY ATTACHMENT FOR ELECTRIC CARS. F. S. Smith, Hartford, Conn., 556,941. Filed June 11, 1895.
Allows trolley to drop whenever pressure of flanged wheel against conductor is relieved.
SAFETY DEVICE FOR ELECTRIC CARS. A. H. Wheeler and J. Gilbert, Warwick, R. I., 556,949. Filed Jan. 2, 1896.
An emergency track brake operated by a lever on platform.
INSULATED SUPPORT FOR CONTACT RAILS. A. Hanson and J. R. Chapman, Chicago, Ill., 556,971. Filed Oct. 30, 1895.
Details of construction.
ELECTRIC TROLLEY. G. R. Mitchell, Newtown, Pa., 557,008. Filed Nov. 22, 1895.
Designed for use on double track railways, having one common overhead conductor.
TROLLEY FOR ELECTRIC RAILWAYS. P. F. O'Shaughnessy and O. T. Crosby, New York, 557,015. Filed Sept. 27, 1888.
A trolley for making an underneath contact with a conductor, a telescopic support for the trolley on the roof of the car, and means extending within reach of the operator for adjusting the trolley.
MEANS FOR SUPPORTING MOTORS AND MOTOR FRAMES. E. S. Breed, New Britain, Conn., 556,049. Filed April 22, 1895.
Details of construction.

Regulation:—

OPERATING DYNAMO ELECTRIC MACHINES IN MULTIPLE. E. Verstraete, St. Louis, Mo., 556,788. Filed Sept. 1, 1894.
A generator having series field coils and field coil in shunt relation to the armature, and other generator supplying the same circuit in multiple, having a set of shunt field coils energized by current taken from opposite sides of the armature of the first generator.
CONTROLLER FOR ELECTRIC MOTORS. E. D. Priest, Schenectady, N. Y., 556,862. Filed April 9, 1895.
A reciprocating resistance switch, a separate reciprocating series parallel switch, and permanently connected means for operating the two switches simultaneously from a single handle.
REGULATING DEVICE FOR CONTROLLING WORKING OF ELECTROMOTORS. R. Thury, Geneva, Switzerland, 556,945. Filed Feb. 3, 1896.
Adapted to railway use.

Switches, Cut-Outs, etc.:—

ELECTRICAL CONNECTOR. P. H. Fielding, New York, 556,967. Filed July 9, 1895.
A bottomless stage or floor pocket, the object being to prevent contact by anything falling therein.
AUTOMATIC GROUNDING DEVICE FOR ELECTRIC CONDUCTORS. G. A. Jewett, Chicago, Ill., 556,823. Filed July 8, 1895.
A part electrically connected with the ground, a second part which is movably attached to a support and which bears against but is unattached to the wire.

Telephones:—

TELEPHONE SWITCH. W. A. Moore, Brooklyn, N. Y., 556,763. Filed Sept. 5, 1895.
The removal of receiver opens switch.

REPORTS OF COMPANIES.

NEW YORK EDISON EARNINGS.

The Edison Electric Illuminating Company, of New York, reports its February earnings (inclusive of high tension systems) as follows:

	1896.	1895.	Inc.
Gross	$195,221.23	$176,715.44	$18,505.79
Net	103,4[illegible].37	82,680.13	20,754.24
Gross, 2 months.........	413,402.77	382,357.97	31,044.80
Net, 2 months...........	220,2[illegible].57	186,998.52	33,291.05

WESTINGHOUSE COPPER MINES.

A special dispatch from El Paso, Tex., of March 24, says: The Westinghouse interests have secured control of the Washington Camp group of copper mines in Pima County, Ariz., the heaviest producing copper properties in the Territory, and took possession of the defunct International Copper Smelting Plant in this city to-day. The price paid for the mines is said to be $70,000, but developing will make them worth very much more than that sum.

A well-founded rumor is that a new smelter of six or eight stacks will be erected by the Westinghouse Company at this central point, and an extensive industry inaugurated to supply the Westinghouse Company with copper for manufacturing purposes. The copper is of the very best.

COMMERCIAL CABLE CO'S. ANNUAL REPORT.

The annual statement of the Commercial Cable Company for 1895 was submitted to the shareholders at their annual meeting last month. The gross earnings amounted to $2,009,738.14, and the working and other expenses to $794,340.53, leaving a balance of $1,215,397.61.

There was an increase in the earnings of $236,304.10, and an increase in expenses of $31,344.69, as compared with the previous year, resulting in an increase in net earnings of $204,959.41.

Dividends of 1¾ per cent. for the quarters ending March 31, June 30, Sept. 30, and Dec. 31 have been paid, a total of 7 per cent. for the year on the capital stock, amounting to $700,000. The reserve fund has been augmented by the purchase of $200,000 United States Government bonds. The balance of the year's profit, amounting to $315,397.61, remains to the credit of profit and loss.

The following directors were elected for the year: J. W. Mackay, James Gordon Bennett, George G. Ward, Sir Donald A. Smith, Sir William C. Van Horne, Clarence H. Mackay, T. Skinner, G. G. Howland, C. R. Hosmer, R. Irvin, G. S. Coe, A. B. Chandler, F. C. Platt.

LEGAL NOTES.

THE VAN DEPOELE PATENT CONTEST.

The Kelsey Electric Railway Specialty Company has appealed to the United States Circuit Court of Appeals at New Haven, Conn., from the order of Judge Townsend granting a preliminary injunction in favor of the Thomson-Houston Company, enjoining the manufacture by the Kelsey Company of a trolley base. The ground of the appeal is that there was no evidence in the case of the Kelsey Company's intention to aid in the infringement of the Van Depoele patent. The Kelsey Company was sued as a contributory infringer, it having manufactured merely the trolley base, which it is claimed was not covered by the patent specifications.

BROOKLYN BOARD OF ELECTRICAL CONTROL.

Assemblyman Perkins has introduced a bill in the New York Legislature which replaces the Brooklyn Electrical Subway Commission by a Board of Electrical Control, to consist of the Mayor and the two present Commissioners, Professor George W. Plympton and Frederick R. Lee. Like the present law, the bill provides that on Nov. 1 the powers of the board shall vest in the Mayor and City Works Commissioners.

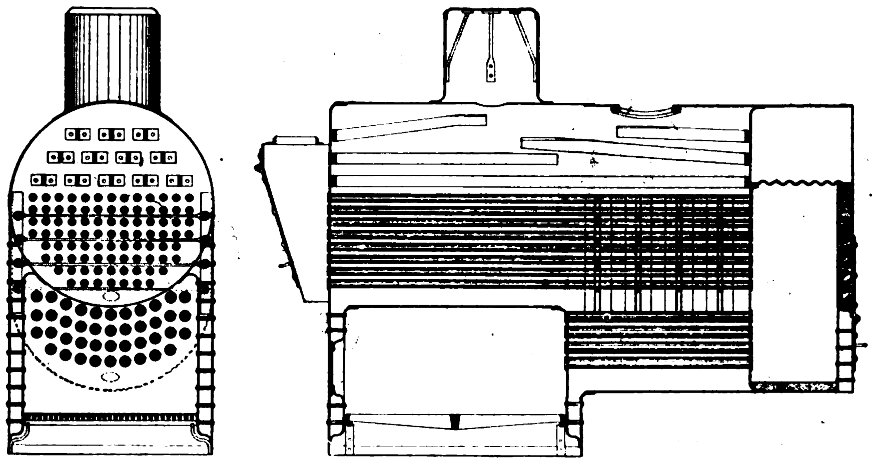
Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

THE ECLIPSE BOILER.

The accompanying engraving represents the Eclipse return tubular boiler. Great care has been taken to distribute the heating surface in a manner to effect rapid and efficient absorption of heat. As much heating surface as possible is brought in direct contact with the fire, and it is claimed more heating surface is secured than in any other internally fired boiler yet introduced. The design also secures sufficient distance of travel of ignited gases to take up all effective heat.

Boilers of this type have heretofore been made with cast iron furnaces, lined with loose firebrick. The great loss of heat by radiation through the sides and front of such furnaces is not only a direct loss of efficiency, but subjects firemen to the discomfort of working in a high temperature, which is avoided with the Eclipse boiler. The absence of water sides and fronts in other boilers of this type is a serious loss of effective heating surface, it being estimated that one-holf the total heat evolved by combustion of coal on the fire-grate of a steam boi er is given out by radiation to the heating surfaces of the firebox. It has been determined by experiment with a locomotive boiler that one square foot of firebox heating surface evaporates from twenty-six to twenty-eight pounds of water per hour.



THE ECLIPSE BOILER.

The Eclipse boiler occupies but little space, and combines the safety of the stationary return tubular type with portability. The front end of the boiler is cylindrical in form, and extends over the furnace, forming the crown sheet. The construction of other parts will be readily understood by reference to the engraving. The crown sheet, being cylindrical in form, is self-sustaining, and does not require bracing. All handholes are so placed that the boiler is readily accessible at all necessary points for cleaning and repairs.

This boiler, which is built by the Kingsford Foundry and Machine Works, of Oswego, N. Y., is made of homogeneous steel plate of 60,000 pounds tensile strength per square inch. All flat surfaces are thoroughly stayed and braced, complying in this requirement with the marine laws of the United States, no stay or brace being subjected to a greater strain than 6,000 pounds per square inch of section.

ANTI-BELL ASSOCIATION IN IOWA.

A special dispatch from Des Moines, Ia., of March 18, says: At the meeting to-day of the anti-Bell telephone companies in the State, nineteen exchanges were present. An organization was perfected, to be known as the Iowa Telephone Association. The companies represented have an aggregate of over $1,000,000 paid-up capital. They have in operation, in addition to thirty exchanges in larger towns, about 2,000 miles of toll lines. The purpose is to connect the systems throughout the State. Practically every part of the State was represented, over forty members being present. A number of the companies operate several exchanges. The association will also control lines in parts of Minnesota and South Dakota.

The association decided on building toll lines from the north and south into Des Moines to connect the systems of toll lines in the north and south part of the State. It is also probable that the association will establish in the State a factory by which all telephone supplies will be manufactured.

E. H. Martin, of Webster City, presided, and E. H. Haines, of Oskaloosa, was secretary. The following concerns were represented by the officers of each that are named: Boone County Telephone Company, of Boone, J. L. Stevens, president, C. E. Wells, secretary, W. H. Crooks, treasurer; Marshall Telephone Company, A. A. Moore, president; Cedar Valley Telephone Company, Waterloo, C. F. Bennett, secretary; Charles J. Cockerill Telephone Company, of Jefferson, C. G. Cockerill, president; the E. H. Martin Telephone Company, of Webster City; E. H. Martin, president; Clearfield and Mount Ayre Telephone Co., H. Baum, president; Clearfield and Lenox Telephone Co., F. A. Ferguson, secretary; Perry Telephone Company, of Perry, George N. Bandy, manager; Iowa and Dakota Telephone Company, of Parker, S. D.; W. A. Houts, secretary; Home Telephone Company, of Sioux City, F. A. Durnell, director; Mutual Telephone Company, of Des Moines, A. T. Hess, manager; Sioux City Telephone Company, H. O. Woodruff, manager; Home Telephone Company, of Oskaloosa, S. T. Slade, manager, and E. K. Hines, secretary; Tri-City Telephone Company, of Clinton, C. B. Miller, manager; Western Telephone Construction Company, of Chicago, J. F. Keelyn, president.

Various committees were appointed, and the following officers were elected:

President, E. H. Martin, Webster City; vice-president, E. T. Hess, Des Moines; secretary, Ed. K. Haines, Oskaloosa; treasurer, S. T. Slade, Oskaloosa; executive committee, Charles E. Wells, Boone; C. F. Bennett, Waterloo; F. A. Durnell, Sioux City; George N. Bandy, Perry.

The chairman stated that the business of the independent companies had increased 50 to 100 per cent. during the last year.

The association will build an exchange in Des Moines in case the company now planning to do so does not succeed.

BERLIN IRON BRIDGE CO.

The Berlin Iron Bridge Company, of East Berlin, Conn., have a contract with the Carteret Steel Co., of Carteret, N. J., for a steel frame to support the furnaces which are to be placed in the new iron building which the Berlin Company is erecting for them.

The Michigan-Peninsular Car Company, of Detroit, Mich., have placed a contract with the Berlin Iron Bridge Co. for a new foundry building, 160 feet square. This building is one story high, has a steel framework throughout, and is so designed that the lower chords of the trusses support runways extending the whole length of the building. These runways carry trolleys having a capacity of 2,000 lbs. By means of these overhead trolleys the molten metal is conveyed quickly and easily from the cupolas to any part of the casting floor.

LINK-BELT MACHINERY COMPANY.

The catalogue of the Link-Belt Machinery Company, Thirty-ninth street and Stewart avenue, Chicago, and New Orleans and New York, reads like a concentrated disquisition on modern mining machinery. The dimensions of the catalogue have advisedly been fixed at 6 x 9 inches, the size recommended by the American Society of Mechanical Engineers as a standard for machinery catalogues, for the pamphlet will be kept

by many of its readers as a work of reference. The cuts and the whole get-up of the work are admirable, and its contents are highly instructive. They show conclusively that electric coal mining machinery has been reduced to a thoroughly practical basis; that it concentrates the workings in the mine and reduces the expense from dead work. It enables the entries to be driven and the rooms to be turned more economically and gives a ready power for drilling, hauling, hoisting, pumping, ventilating and lighting. Electrical machinery adapted for all these operations is described in the catalogue. Among the most interesting features of the pamphlet are the illustrations of the storage plants used for the storing and reloading of coal, some of which have a capacity of hundreds of thousands of tons.

GENERAL ELECTRIC HOISTS.

THE application of the electric motor to portable hoists for derricks is illustrated admirably in the two hoists which the General Electric Company has lately furnished the United States Government, in connection with an important electrical installation. These hoists are of the double drum and single

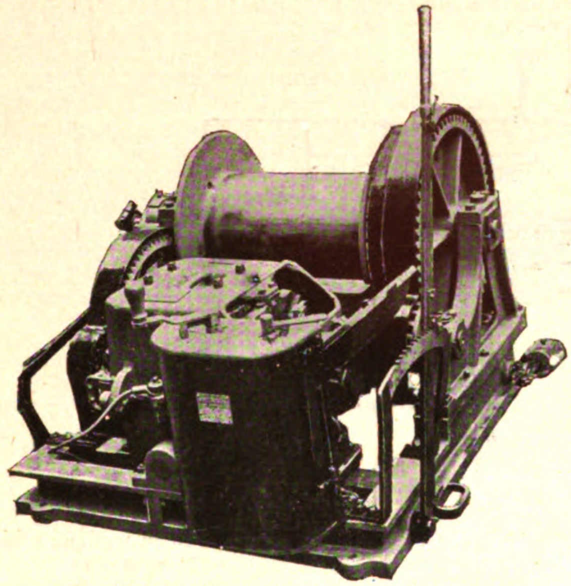


FIG. 1.—GENERAL ELECTRIC HOIST.

drum type, respectively, the double drum hoists being operated by a 20-horse-power motor, the single drum hoist by one of 10 horse-power. Each motor is mounted upon the same bed plate as the hoist and is of a late and efficient type, resembling in general appearance the well-known railway G. E. 800. The parts of the motors are all readily accessible for examination and repair, but are entirely covered in by the motor casing and are thus fully protected against dust, moisture and mechanical injury.

The armatures are iron clad, each coil lying in a slot in the iron core entirely below the outside surface. The motors are sparkless and the bearings are self-oiling. The controllers are known as M. R., and embody all the excellent features of the controller K2 used in street car work.

The levers for the brakes, controllers, etc., are so arranged that full control of the entire mechanism is had without change of position by the man in charge. The hoists themselves are from the works of the Lidgerwood Company. The drums are 14 inches in diameter and 26 inches long.

THE CRANDALL ELECTRIC SIGNAL.

Secretary Herbert, members of the Senate and House Committees on Naval Affairs, General Greely, Chief Signal Officer, U. S. A.; General Flagler, Chief of Ordnance, U. S. A.; Rear Admiral Ramsay, Chief of Navigation; Commodore Hichborn, Chief Constructor; General Dumont, Supervising Inspector General of the Steamboat Inspection Service; Superintendent Kimball, of the Life-saving Service, and a number of other officials, witnessed on March 24 an exhibition of a new electric signal for use at sea and on land, the invention of L. S. Crandall. The exhibition took place in the sub-basement of the Navy Department building and was conducted by the inventor. A display frame, containing numerous incandescent electric light lamps, so arranged as to contain all the elements of every letter in the alphabet, composes the signalling apparatus proper. To this is attached a keyboard similar to that of a typewriter, and, pressure on each lettered key so switches the current that the letter indicated is formed in brilliant curves and hues. It is claimed that the device will show plainly at the distance of five miles.

A SUCCESSFUL WOMAN INVENTOR.

The progress now being made by the New Woman is illustrated in the recent success of Mrs. Lottie Cox, of Blue Springs, Nebraska, who has just been awarded a prize of $150 for the best and simplest invention submitted to the patent firm of John Wedderburn & Co., Washington, D. C.

Mrs. Cox is the first woman who has been successful in these monthly competitions which have now been in progress for the past year. She is forty years of age and styles herself a "self-made woman." She was left a widow at twenty, with two small children, and thrown entirely on her own resources. While engaged in daily labor to support herself and children, she experimented with various ideas, and finally evolved a work table, supplied with numerous conveniences much appreciated by women. Although somewhat stinted as to means, she bravely undertook to patent her invention, and, having submitted it to Messrs. Wedderburn & Co., in connection with their patent awards, received the prize of $150 in the February contest.

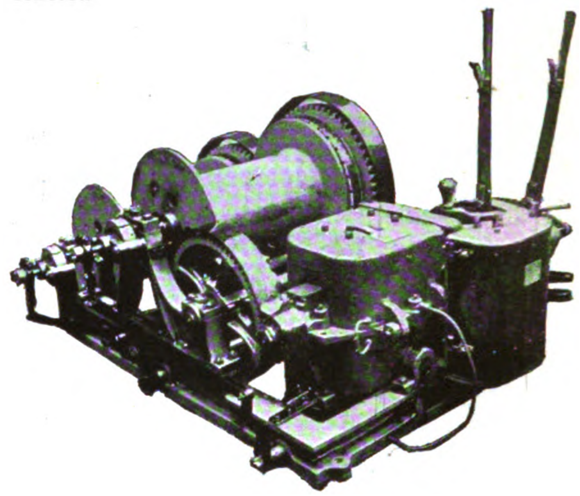


FIG. 2.—GENERAL ELECTRIC HOIST.

Mrs. Cox declares she is much encouraged at her success, and hopes to follow it with the completion of other inventions now under way. This would seem to be a most edifying example for the emulation of her sisters, who are now absorbed in the endeavor to imitate men in far less profitable enterprises.

NATIONAL UNDERGROUND CABLE CO.

Mr. Edwin S. Reid, who has been with the Standard Underground Cable Company for many years, as superintendent of construction, has severed his connection with that company and has accepted a position with the National Underground Cable Company, with main office at New York and branch offices at Chicago, Philadelphia, and Boston, as its general superintendent of construction, and all construction work done by the National Company will be under his immediate charge and supervision.

Mr. Reid, who was for many years associated with Mr. Stephen D. Field, in his various electrical works, entered the underground cable business in its earliest days, and many of the appliances used on underground cable work, which have tended to make underground cables successful are of his invention and design.

The well-known Reid cable terminal, which was invented by him only a few years ago, has given such satisfaction and met the requirements of the users so well that over 100,000 of them are in use to-day in the United States and Canada on telephone, telegraph and electric light cables for underground and aerial service.

There are but few underground systems in the United States which Mr. Reid has not had something to do with, and his experience covers not only the construction of cables, but also the building of complete subway systems; and, besides, he has the advantage of being able to make the most delicate and complicated electrical tests, and of being master of electrical subjects generally.

Mr. Reid has already started in on his work with the National Underground Cable Company, and in the hands of one so competent, the most satisfactory results are certain to be obtained.

The National Company is certainly surrounding itself with the most competent men obtainable, and is to be congratulated upon its enterprise and progressiveness.

A MICA SAMPLE CARD.

Eugene Munsell & Co., 218 Water street, New York, importers and wholesale dealers in India and Amber mica, are sending to the trade a large sample card, showing a variety of forms of mica for electrical insulation, stamped solid mica segments for all the standard railway motors, mica washers, etc. At the top of the card appears the company's name and address, in heavy, bold type, as importers of pure India mica for electrical insulation, and the statement that the mica can be furnished in Amber quality. The lower part of the card is given up to the list of agencies in the principal cities—Chicago, W. H. Sills & Co.; St. Louis, A. S. Partridge; Cincinnati, Sinclair Randall; Cleveland, the Cuyahoga Supply Company; San Francisco, J. W. Brooks & Co. The company is in a position to furnish mica in both India and Amber quality; in the sheet, or cut to any size or pattern; mica segments gauged to thickness for all the standard railway motors.

LUNDELL FAN MOTORS.—"WHITE WINGS."

THE Interior Conduit & Insulation Co. have issued a handsome and complete catalogue, showing their line of Lundell fan motors for the season of 1896. These machines—some 20,000 of which are now in actual use—are so well known throughout the country that a description of them is entirely superfluous. Special mention, however, should be made of several new styles which are now offered for the

LUNDELL CEILING FAN.

first time. The Lundell "White Wings," illustrated, is a decided novelty. This is a ceiling fan motor with aluminum blades, made in two sizes, and especially adaptable for low studded ceilings. The outfits are complete and most efficient, of handsome design, and are very low-priced. New designs in suspended and bracket fan motors are also shown in the catalogue. This large and varied line of Lundell fan motors will meet with the commendation and recognition of the trade at large.

THE NEW YORK ELECTRIC FACTORY.

J. L. Ludwig, connected with the Walker Company, of Cleveland, O., which is to locate here in a factory on Winchester avenue, is in the city and will take charge of the operators. He expects to open the factory in about six months with a few men and increase the number as fast as business will warrant it. He will employ New Haven men. He confirmed the statement that the Walker Company had purchased the machinery and business of the Consolidated Electric Company, of Boston, and added that the business previously done by that company, what was left of that done by the Standard American Electric, the former occupant of the Winchester avenue factory, and certain kinds of work being done in the Cleveland factory of the Walker Company, would be done in the factory in this city.—New Haven "News."

ROCHESTER, N. Y.—The Irondequoit Park R. R. Co., of Rochester, N. Y., have contracted with W. J. Creelman, of that city, agent of the Stearns Manufacturing Co., for their complete power equipment, consisting of two 100-horse-power Woodbury engines, two 100-horse-power boilers, line shaft, pump, heater, etc. The road will be in operation early in May.

WHERE THE NEW COPPER GOES.

A good idea may be gathered of the extent to which transmission of power by electricity is gaining ground in this country by the statement, that in the long-distance plants installed by the General Electric Company during 1895, over 1,200 miles of copper wire for transmission purposes alone were used, amounting practically to 1,200,000 pounds of copper.

UNDERGROUND CABLES FOR THE BOSTON WEST END RAILWAY.

The National Underground Cable Company has just received an order from the West End Street Railway Company, of Boston, covering all the lead-covered underground feeder cable to be used by the latter company during the year 1896.

The first work to be done on this contract will be for about twenty-one miles of 500,000 circular miles cable and two miles of 1,000,000 circular mils cable. The West End Company has been using for some time large quantities of the National Company's cable, and the giving of this order speaks for itself as to the quality of the cable and the satisfaction it has given. This contract of the National Underground Cable Company covers also the laying and connecting of the cables in Boston, and the doing of all the work.

WESTERN NOTES.

MR. C. O. BAKER, who was recently appointed manager of the Western office of the Anchor Electric Company, of Boston, Mass., is now settled in his new quarters, 1654-5-6 the Monadnock, Chicago, where he has a complete line of samples of the electrical goods manufactured by his company.

MR. J. E. WAY, New York, manager of R. Thomas & Sons headquarters at the office of Grier Bros., who are Western agents for the concern.

MR. THOS. GRIER will read a paper on April 17 on "Little Economies in Central-Station Practice," before the Chicago Electrical Association.

THE AMERICAN CIRCULAR LOOM COMPANY, 1114 the Marquette Building, Chicago, have just issued a new alphabetical directory of all the office buildings in Chicago, with their locations. This little book, which is very tastefully got up, has a complete list of all the buildings in the Western metropolis, which number some 200. It will supply a long-felt want, and will be of great use not alone to strangers who visit the city, but to many who reside there permanently, as even numbers of the latter are often at a loss to locate readily some of the many small office buildings with which the city abounds. The book, which is vest-pocket size, has a neat, dark-colored leather paper cover with its title and the publishers' names printed on the front.

MR. E. M. SCRIBNER, who has for a considerable time been connected with the Western Electric Co., Chicago, is about to sever his connection with that concern, and will, after April 1, enter another responsible postion with the Bryant Electric Co., at their factory in Bridgeport, Conn. Mr. Scribner has the best wishes of his friends for his future success.

MR. J. D. M'INTYRE, representing Pass & Seymour, Syracuse, N. Y., was a Chicago visitor last week.

THE ELECTRIC APPLIANCE COMPANY is distributing two catalogues which should be in the "catalogue library" of every electric light station in the country. One of these is their catalogue of Paiste specialties, and the other of P. S. porcelain specialties. Both of these catalogues are supplied with special trade discount sheets, giving the latest and lowest trade prices on these goods, and are hence valuable information to the close buyer. Copies will be cheerfully furnished on application.

THE TRUMP MANUFACTURING COMPANY, of Springfield, O., has secured an order from the Street Railway Company of Oswego, N. Y., for two Trump turbines. They are for the new power house to be built on the site of some old mills, and will develop 642 horse-power on a horizontal shaft.

DENVER, COLO.—Incorporation papers have been filed in Denver, Colo., for a company, the purpose of which is to purchase the street, electric and cable railroads of Denver and consolidate them under one management. The capitalization of the company is $3,700,00, and the incorporators are G. H. Holt, C. D. L. Huilen, William Cole and Charles Sheehan, of New York City; Joshua Wilbour, of Providence; Arthur Knight, East Greenwich, R. I., and George E. Randolph, receiver of the cable line of Denver.

ELECTRIC BORING.—Messrs. Siemens & Halske, of Berlin, have recently secured a contract for an electric boring plant for the State salt mines at Hallein. The plant will comprise a high-pressure turbine, coupled direct to a continuous-current dynamo and two boring machines.

A NOVEL STREET CAR IN CLEVELAND.

The Cleveland "Recorder" of March 26 has the following item. The battery used is the Washburn, and the motor was also designed by Mr. Washburn. Mr. Shipherd is a large street railway owner:

J. J. Shipherd, of this city, one of the gentlemen interested in the United Motor Company, which has been conducting a series of experiments in regard to use of storage batteries as a means of propulsion on street cars, stated yesterday that he was very well satisfied with the experiments so far made.

"The theory is a beautiful one," said Mr. Shipherd, "for the new system would do away entirely with expensive power plants and cumbersome, dangerous overhead wires. You see the system we are working on is not to charge a battery and then let it run down, as has been the method in vogue with most inventors, but we carry a gasoline tank, and, by manufacturing our electricity on the car, are able to keep up the maximum of power with the minimum of expense.

"Just as long as the gasoline in the tank holds out, just so long we can run. I could not tell you just how much gasoline we can carry, but I do know that there is enough to make power for 24 hours.

"We have a car running on the Superior street tracks after the cable stops. The work done is very good so far, and we all believe the method of transmitting power now in use will be superseded by the storage battery in time.

EDISON BUYS BACK HIS OWN PHONOGRAPH.

Thomas A. Edison has bought from the New Jersey receiver of the North American Phonograph Company all his own rights and property, and, after a bitter experience rarely equalled by that of any other great inventor, is going to see what he can do for himself with the phonograph.

He has thoroughly perfected and is going to put on the market a cheap spring motor phonograph to sell for about thirty-five or forty dollars, which will run two of the ordinary cylinders on one winding.

The Edison Phonograph Works, near the laboratory, at Orange, will build the apparatus, and the National Phonograph Company, of Orange, N. J., has been formed to handle the selling end of the business. Hitherto, there has been a territorial system, like that of the telephone, but the new company has determined to get right to the people by appointing selling agencies in all of the large cities throughout the country like those for the sewing machine and bicycle.

MR. FRANK H. BALL.

The American Engine Co., Bound Brook, N. J., have secured the services of Mr. Frank H. Ball as manager of their business. He will add to their present line of steam and electrical machinery a full line of his celebrated engines, especially adapted for direct connected electrical work.

Mr. Ball is widely known as one of the best engineers in this country, and the American Engine Co. are to be congratulated on the new order of arrangements.

NEW YORK NOTES.

MR. L. J. MONTGOMERY, Secretary of the Electricity Newspaper Co., who has been with that firm since its inception, has resigned his position, in order to take charge of the business department of another publication.

R. HOE & CO., of New York City, manufacturers of printing presses, have placed an order with the Berlin Iron Bridge Company for an all-steel building for storage purposes. This building is 40 feet wide and 60 feet long, 3 stories high. It is absolutely fire-proof. To avoid condensation of moisture, the roofs and sides are lined with the Berlin Company's patent anti-condensation fire-proof lining on the underside of the corrugated iron covering. The floors are concrete, supported by corrugated iron arches, resting on I-beams. A traveling crane is attached to the trusses, having a capacity of 3 tons, and so arranged that it takes the material to be raised in the building from the lower floor, and raises it to any part of the building on any of the floors. It is a very conveniently arranged and compact storehouse.

MR. C. O. MAILLOUX, the consulting electrical engineer, has of late found his business increasing so rapidly that he has had to move to the American Tract Society Building, where he has double the amount of floor space occupied by his offices hitherto, and where he will have improved facilities for drafting, etc.

THE ROESSLER & HASSLACHER CHEMICAL CO., of New York, are having a brisk demand for barium platino cyanide and ammonium platinum cyanide, both of which chemicals are extensively used in X-ray experiments. There appears to be a greater demand for these goods than ever, and this company are particularly well equipped to furnish this necessity in any quantity.

MR. A. A. DE BONNEVILLE, the popular steam pump salesman and engineer, has resigned his position with the Geo. F. Blake Manufacturing Company, and will in the future represent M. T. Davidson, manufacturer of steam pumps, at 133 Liberty street, New York.

J. H. M'EWEN MANUFACTURING COMPANY, Havemeyer Building, have issued a neat and interesting illustrated catalogue on their Thompson-Ryan direct current multipolar electric generator which has lately received so much attention.

THE ELECTRIC LAMP COMPANY, of Buffalo, has been formed with a capital stock of $100,000. The directors are T. H. Spaulding and J. R. Keim, of New York City; T. F. Crane, of Brooklyn; H. H. Fulton, of Elmira, and D. L. Whittier, of Indianapolis.

THE RUSHMORE DYNAMO WORKS find it necessary to run their factory night and day to keep up with orders for their new lens mirror projectors. The great power of the new projectors, together with their simple construction and perfect performance, has overcome the prejudice which formerly existed, and they are now placing their apparatus on all kinds of vessels on both coasts, the great lakes and Western rivers, besides equipping several warships. They have recently replaced a number of the finest projectors of foreign make, as it was shown that the Rushmore light had four to five times the power for the same current consumption. They are now making their own lenses, and their grinding plant is said to be one of the finest in the country for this class of work.

"THE PHOTOGRAPHIC TIMES" for March contains over 100 pages. The articles are interesting and valuable to camerists and the numerous illustrations are fine specimens of engraving. Considerable space is given to X-rays, one article being contributed by Mr. Osterberg. The "Times" has used the articles in "The Electrical Engineer" of Feb. 5 on Professor Wright's cathodographs and the Moore etheric light, and has also quoted this paper's articles on Professor Röntgen and Mr. D'Infreville's seeing and photographing in the dark.

"HOW TO SPRAY" is the main title of a clever little pamphlet issued by the Goulds Manufacturing Co, of Seneca Falls, N. Y., and devoted to their spray pumps and spray nozzles. It not only contains a mass of trade data relative to pumps and nozzles, but gives a variety of formulas as to solutions for spraying plants and when to use them.

PHILADELPHIA NOTES.

STERN & SILVERMAN have contracted with the Dayton Traction Company, of Dayton, O., for the building of their line from Dayton to Miamisburg, O., a distance of twelve miles. The contract calls for the furnishing of the roadbed complete with bridges, cars, trucks, motors, Corliss engines, boilers, dynamos, and steel and brick carbarn and power station, all to be in operation by July 1, 1896.

THE KENSINGTON ENGINE WORKS, LTD., of Philadelphia, Pa., have recently sold three 100-horse-power return tubular boilers of 125 pounds working pressure to Haddon Hall Hotel, Atlantic City, N. J., also a 200-horse-power feed water heater of special design to the Atlantic Refining Company, of Point Breeze, Pa.

NEW ENGLAND NOTES.

THE AMERICAN ELECTRICAL WORKS, of Providence, R. I., have issued a very pretty calendar with a water-color picture on it of their Phillipsdale mills, into which is also vignetted their large factory in the City of Providence.

MR. ALONZO KEAN, East Boston, Mass., one of the early graduates from the Thomson-Houston Expert Course, Lynn, who was for about eight years in the Construction Department of the Thomson-Houston Electric Company, and about two years in the Construction Department of the General Electric Company, Boston, Mass., has received an appointment as chief electrician for R. H. White & Co's., new plant, Boston, Mass.

MR. F. A. ABBOTT, who was with the Boston Electric Light Company for eight years, and with the Edison Electric Illuminating Company, at 3 Head Place, for the last four years in the Meter Department, has organized the Abbott Electric and Gas Engineering Company in Boston, with offices at 66 Bowdoin street. Mr. Abbott has had wide experience in the electrical field, and has already received indications favorable to his new business.

Department News Items will be found in advertising pages.

THE
Electrical Engineer.

Vol. XXI. APRIL 8, 1896. No. 414.

ELECTRIC LIGHTING.

ARE ROENTGEN RAY PHENOMENA DUE TO SOUND WAVES?

BY

Thomas A. Edison.

FURTHER experiments with the Röntgen ray have developed some new phenomena which may aid in explaining the mode of transmission. In studying various photographs taken in the past month there were certain features which were difficult of explanation except on the theory that the X-ray was a sound wave of very small wave length, and that the shadows were sound shadows, the peculiarities of which are known, one of the best illustrations being the experiments of Le Conte in the Bay of San Francisco, published in the "Philosophical Magazine," February, 1882.

The experiment was briefly this: Le Conte placed a bottle under water on one side of a pile; at a distance of 200 feet from the pile he exploded a charge of nitro-glycerine, also under water. The concussion wave shattered the bottle. He then placed it behind the pile and exploded a charge. The bottle

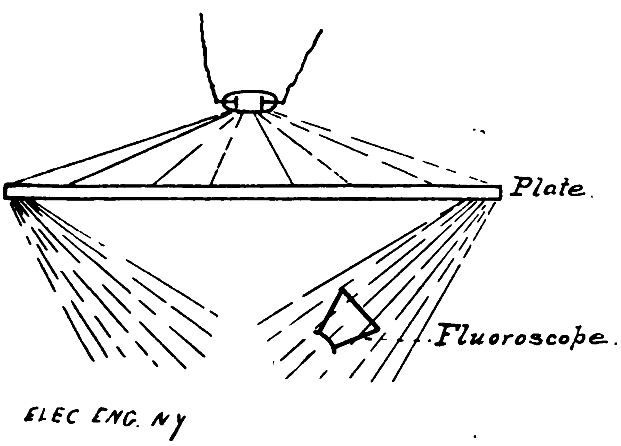


FIG. 1.

was uninjured. In another experiment he placed a glass tube at right angles to the pile, its ends projecting a couple of feet on each side. The portions within the shadow were uninjured, the ends were broken off. I therefore conducted a number of experiments with this theory in mind.

The fluorescent bulb was placed on one side of a steel plate, Fig. 1, the observer being on the opposite side. When the fluoroscope was placed against the steel plate directly opposite the bulb on the other side, no light was observed; but when the fluoroscope was made to approach within six inches of the edge and well within the shadows it lighted up. The direction of the X-ray was found by a moving bar of iron, so as to obtain the sharpest image. Fig. 1 illustrates the direction of the ray as near as possible with the rough apparatus used.

The second fact which possibly tends to confirm the sound wave theory is that liquids do not fluoresce with the ray, at least none that I have tried. Crystals alone fluoresce, except in one or two cases, such as precipitates, and these may not be amorphous. The crystal is resonant to the wave.

The third observation is that a tube with a vacuum so low as to give striae and from which ordinarily no X-ray can be obtained, no matter how long a dry plate is exposed to it, can be made to give the ray by a powerful blast of air on the spark of the break wheel of the primary and a spark gap in the secondary, the wires of which are guarded up to the very end.

Another observation is that the sharpness of the shadow depends on the abruptness of the break. A very weak bulb may be made to give sharper shadows than one giving twice the luminosity in the fluoroscope, which has a connection with this theory. Another fact is, that when tubes are on the pump continuously the vacuum will depend upon the pump, that is, the amount of mercury running per minute. The vacuum will reach a certain stage and keep that way for several days, the pump being able to reach a certain exhaustion, and no further, the air brought in by the mercury being the limiting point.

With Sprengel pumps used for incandescent lamp exhaustion the stage of vacuum reached is rather too high for the best X-ray, but still very good. But if a device is used whereby a definite amount of air is permitted to enter the bulb the X-ray will flash out with great brilliancy in the fluoroscope, lasting for 10 or 15 seconds until the pump has exhausted it to the limiting point mentioned. With this device a moving object can be seen through 30 inches of pine board. By means of the fluoroscope the bones of the arm and shoulder are of extraordinary sharpness.

[For the benefit of our readers we print below the article above referred to by Mr. Edison.—Eds. E. E.]

EXPERIMENTS ON SOUND SHADOWS.

"Experiments with Stout Glass (soda water) Bottles."—In these experiments the observer stood on the top of a vertical cylindrical pile (the trunk of an Oregon pine) about one foot in diameter, situated about forty feet horizontally from the explosive cartridge. The bottle, being secured to a rigid rod, was first plunged under the water from ten to twelve inches behind the pile (Fig. 1, A), that is, within its geometrical shadow. The shock of the explosion did not injure the bottle. It was then plunged into the water in front of the pile (Fig. 2, B), or outside its geometrical shadow. In this position the bottle was

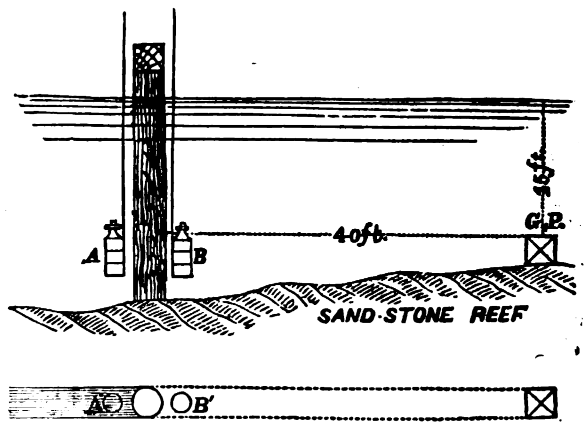


FIG. 2.

shivered to atoms by the concussion due to the explosion. As viewed from the experimenter's situation on the top of the pile, Fig. 1, A' and B', indicate the two positions of the bottle in the preceding experiments.

The experiments were varied by plunging bottles into the water in various positions around the pile, within and outside of its geometrical projection from the explosive center; and in

all cases they were protected from injury when within the geometrical shadow, and were shivered when outside of the same. The same results took place whether the bottles were filled with water or with air.

The breaking of a glass by a sudden shock communicated by means of water is a fact long known, and is illustrated by the old familiar class experiment of exploding a "Prince Rupert drop," while its bulb is plunged into an ordinary apothecary's phial filled with water.

"Experiments with Stout Glass Tubes."—The cylindrical glass tubes employed were about six feet long and 1.5 inches in diameter, the glass being about 0.5 of an inch in thickness. They were covered by pasting cartridge paper over them, so as to prevent the loss of fragments when breakage occurred.

The tubes were adjusted to a framework of wood so arranged that they could be plunged in a horizontal position beneath the surface of the water behind the pile, the axis of the tube being at right angles to the plane of its shadow, and held there (the

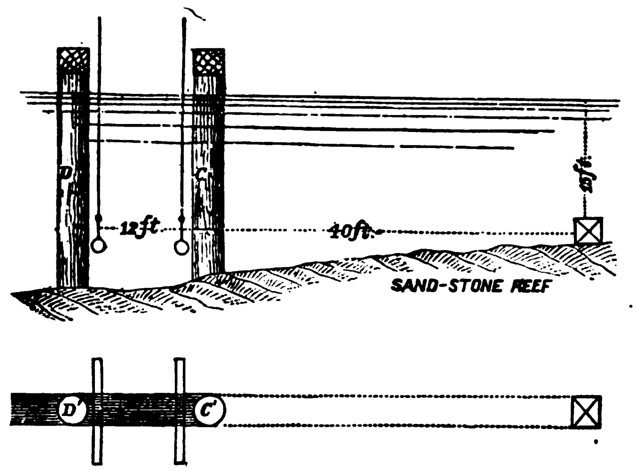


FIG. 3.

observer standing as before on the top) with the middle of the tube in the geometrical shadow, while the two extremities projected on either side about 2.5 feet beyond the boundaries of said shadow (Fig. 3, C and C'). In every case the shock of the explosion shivered the projecting portions of the tube, and left the portion within the shadow uninjured. The boundaries between the broken and the protected portions of the glass were sharply defined.

By standing on the top of a second pile, in the direction of the axis of the shadow of the first pile, and distant about 12 feet, the experiments were varied by plunging the framework and tubes—adjusted at right angles to the plane of the prolonged shadow—into the water at this distance (12 feet) from the obstacle which obstructed the sound wave transmitted by the liquid (Fig. 3, D and D'). The shock of the explosion produced sensibly the same results as when the tube was near to the obstructing obstacle. The protected portion of the horizontal glass tube was sensibly equal in length to the diameter of the pile casting the shadow; hence the shadow of the cylindrical pile extended back for about 12 feet between sensibly parallel vertical planes, and its boundaries, at this distance, were still sharply defined.

DOCTORS TO BECOME CATHOGRAPHERS.

Cathodography will shortly be one of the regular features of the Post-Graduate Hospital, Twentieth street and Second avenue. The utility of taking X-ray pictures in surgery has been demonstrated so often that the hospital authorities have decided to set aside one of the smaller wards for that purpose; and they will equip it with Crookes tubes, Rhumkorff coils, sensitized plates and all the other paraphernalia of the new art. For the generation of electricity they will employ a powerful machine, which has heretofore done service as an ozone generator.

GIFT OF A PLANT TO BLAIRSTOWN, PA.

John I. Blair, a millionaire, has just completed an electric plant at Blairstown, Pa., and presented it to Blair Hall. The plant cost $15,000. The current was turned on for the first time a few days ago, 67 lamps being used to light the town.

THE ROENTGEN RAY SOURCE.

BY

Elihu Thomson

SINCE writing my brief statement, in which it was set out that the anode was possibly the source of the Röntgen rays within the Crookes tube, and not the cathode, I have continued my experiments and investigations and have come to the conclusion that I was mistaken, largely owing to the particular structure of the tubes tested. Indeed, my later experiments have led me to this conclusion, which I think will require no amendment, namely, that the Röntgen rays are produced by the bombardment of any surface within the Crookes tube by cathode rays, or the radiant matter of Crookes; that fluorescence has nothing whatever to do with it, since substances which are bombarded and which do not fluoresce give out the rays—notably a piece of platinum. Lead glass, which fluoresces less than German glass, is still a strong source of the Röntgen rays when bombarded by the cathode rays. I have also been led to the conclusion that the more fluorescence there is produced by the bombardment the less energy will be available for Röntgen rays.

Another result of my observations has been to determine the fact that the Röntgen rays are emitted in all directions from the bombarded surface, and are not special to any particular direction. They are even emitted backward towards the cathode from which the rays which bombard the surface are sent.

In my experiments I find a very convenient way to determine the direction of the rays to be a modification of the fluorescent screen. In this tube a small patch of fluorescent material is mounted at some point between the two ends of the tube itself and backed by dark paper as usual. An opening for the eye is provided at one end of the tube and a moderate size opening at the far end, or the one nearest to the Crookes tube, while the whole screen tube is made of metal to prevent any lateral entrance of Röntgen rays. It will be evident that in this case, when the eye and the fluorescent patch and the distant opening are in line with the source or point of emission of the rays in the Crookes tube, fluorescence will be obtained, but at no other position. Hence, when the tube is so pointed or adjusted that fluorescence is seen it is only necessary to follow back the direction of the tube to lead to the source of the rays. By changing the direction in which observations are made, it is very easily seen that all of the directions determined will converge at some place which is the source of the rays. In this way it was found that with a small piece of platinum in the center of the bulb upon which bombardment occurred from a concave cathode, such platinum became the source of Röntgen rays, and that it did not show the slightest trace of fluorescence.

It was also found that where the rays struck the walls of the bulb, whether they were of lead glass or of German glass, Röntgen rays were emitted in all directions from the place where the radiant matter struck, and that when such rays were projected down and along a tubular extension from the bulb containing the cathode, and opposite which tubular extension the cathode was mounted, the sides of this tubular extension became a source of Röntgen rays, sent out in many directions, even in directions which were towards the cathode terminal.

Since experimenting with the special fluorescent screen which is mentioned above I note that experiments carried out in an entirly different manner by Messrs. Scribner and McBerty,[1] have brought them to the same conclusion, and I also note that Professor Stine has, by following still other methods of investigation, found that the rays are emitted from the bombarded surface. It is interesting, further, to find that, according to an account appearing in "The Electrical Engineer," page 340, an improved tube designed by one of the Professors of King's College, London, has a piece of platinum, which is made the anode for convenience, and which platinum becomes, when bombarded by the cathode rays, the focalized source of Röntgen rays within the tube. I may say that one of the best tubes in my possession, and one which gave the sharpest image, had a piece of platinum foil mounted in the focus of the cathode rays, which platinum foil had become sagged or bent at an angle, its structure resembling the last mentioned tube designed in London except that it had a separate anode.

HOLYOKE, MASS.—The Connecticut River Manufacturing Co., Holyoke, Mass., have purchased a 40-h. p. Ball engine for electric lighting from J. H. Houghton, Boston representative of the Ball Engine Company, Erie, Pa.

[1]See page 358. [2]See page 357.

I. CENTRALIZING X-RAY BULB.
II. EXTERNAL ELECTRODES VACUUM BULB.

BY WILLIAM JAMES MORTON, M. D.

I.

IN a communication to the March 25th issue of this journal I described an experiment which seemed to demonstrate that the X-ray proceeded from a piece of fluorescent material mounted within the bulb, independent of its walls, and mentioned that I had had constructed and was using a Crookes tube so modified as to embody this idea. The main purpose of the independently mounted fluorescent substance was, as then stated, to receive upon its surface the focused cathodic stream at such an angle that the X-rays might be projected out of the tube in a directive manner. Incidentally I proposed the query, based upon the experiment referred to, as to whether the X-ray might not proceed from the fluorescence only. In this issue I take pleasure in submitting a photographic illustration, Fig. 1, of the centralized X-ray bulb then referred to and described.

The cathode is shown at C, Fig. 2; the anode at A; F, is a piece of fluorescing substance.

The fluorescent material is placed at an angle to the cathodic stream and in such a position as to most conveniently permit of radiation proceeding outward through the sides of the bulb.

I have also had constructed a bulb resembling this one, with

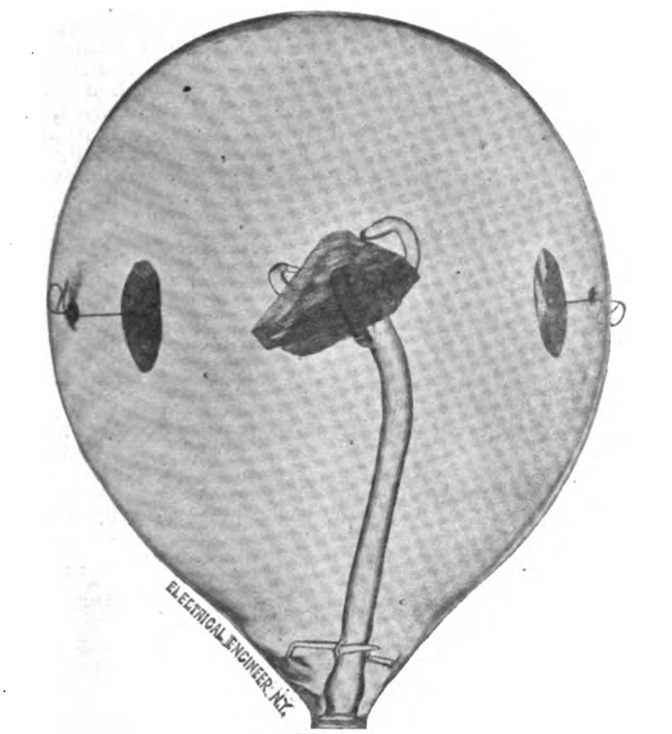


FIG. 1.

the exception that both electrodes focus upon the fluorescent substance.

The bulb illustrated was made for me by Messrs. Eimer and Amend. Any one of a great variety of fluorescent substances may be thus mounted and acted upon.

II.

Unable, like most others interested in making Röntgen pictures, when the announcement of their possibility was first made, to obtain Crookes' tubes, I was forced to turn to other devices of vacuum bulbs.

Omitting details of many experiments, I would like to record, for the benefit of those who wish to work upon this subject, a final form of vacuum bulb which I have arrived at which seems to embody a practical principle of construction, namely, that in a vacuum bulb provided only with external electrodes, the cathodic stream is projected opposite to and against the anodal electrode and its line of projection passes through the anode to reach the sensitized plate.

With this bulb—and it is the only one I, for a long time, used —I made shadowgraphs of the hands, feet, wrist and elbow. It was used with an eight-plate (discs thirty-two inches in diameter) static machine, connected in the circuit existing between the external armatures of Leyden jars, and without a converter of any sort. I found it preferable to use small Leyden jars. But it may also be employed in connection with the induction coil or coil and converter.

The bulb was blown and the vacuum made by Messrs. Eimer and Amend. Reference to the following illustration will enable any amateur to make one: The bulb is about 7½ inches long by 4½ wide. Fig. 3 shows its appearance before the electrodes are fitted to it. Fig. 4 requires a brief explanation. The

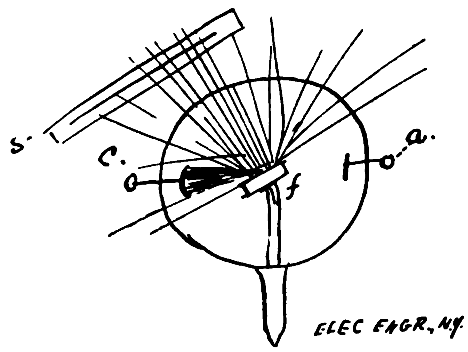


FIG. 2.

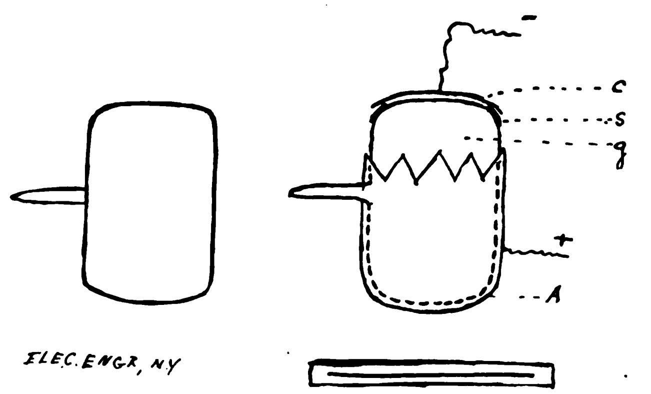
cathode, C, is a disc of thin sheet aluminum about the thickness of ordinary tinfoil annealed and affixed and fitted directly upon the glass with mucilage; its diameter is 3½ inches. Beneath its outer edge is a thick coating and ring of shellac, S, for the purpose of raising the periphery of the cathode disc up and away from the glass, and thus to prevent a possible perforation.

The anode, A, is also of annealed aluminum affixed to the glass bulb with mucilage and completely enveloping its end opposite the cathode and also its sides, with the exception of a small portion of the glass marked g. The anode thus forms practically a metallic cup, within which about two-thirds of the glass bulb sets.

The top of the cup is cut in the form of large serrations in order to provide for a possible sparking over between the two electrodes. If the distance between the two electrodes and the serrations are not properly arranged the glass may be easily perforated.

Running the static machine at fullest practical speed and employing Leyden jars one inch in diameter and seven inches long, coated with tinfoil over one-half of their length, I am able to excite the bulb with a spark extending over a spark gap at the discharging rods of one and one-half to two inches. The cathodic stream from C strikes violently against the opposite end of the tube and causes an active yellowish fluorescence. The sensitive plate is exposed, as indicated, opposite to the anodic end of the tube. The distances I have found most practicable are from 4 to 8 inches. I use a lead diaphragm at the anodic end, having an aperture of from one to two inches.

It will be noted that there is no window or opening in the anode and that the anode, or a considerable portion of it, intervenes between the cathode and the sensitized plate. Should a window be cut in the anodic metal with the hope of getting



FIGS. 3 AND 4.

a better effect upon the sensitized plate the efficacy of the bulb will be greatly diminished.

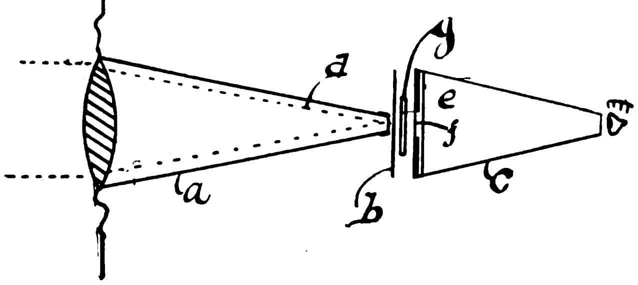
My apology for presenting these details is that this bulb works well with a static machine (or with an induction coil) and that it may prove of interest to many who own such machines to construct their own X-ray bulbs.

PHOSPHORESCENCE AS THE SOURCE OF X-RAYS.

BY EDWARD P. THOMPSON, M. E.

ONE of the most important facts necessary in order to determine the nature of the X-rays is that which will prove their source. In the first place Prof. Röntgen alleges that they radiate solely from the phosphorescent spot upon the Crookes tube. Dr. Morton's experiment indicates the same feature. M. Charles Henry thinks he obtained X-rays from a phosphorescent substance, which he exposed to the light. Niewenglowski finds that phosphorescent bodies increase the penetrating power of sunlight like the sulphide of zinc increases that of X-rays. Poincaré at an early date advanced the hypothesis that the rays are due to phosphorescence, whether produced by electrical or other means. Professors Thomson and Rowland maintain that they radiate from the anode. Tesla has obtained effects by a closed bulb without any electrodes. In one of Tesla's experiments, he employed only one and either electrode, while the other was away off in space somewhere, and yet he obtained penetrating power at great distances. He is convinced that phosphorescence is not the source, because he believes that aluminum X-ray tubes do not phosphoresce. He gave no other explanation. Silvanus P. Thompson thinks that certain of his experiments prove that the rays do not come from either the cathode or from the phosphorescent spot individually, but jointly from both.

I have obtained fluorescence from X-rays after they have passed through a fluorescent substance. Experiments have also proved, apparently, that there are no X-rays radiating from the arc light, sun, flames or other sources of light. Other experiments show that although a Crookes tube may phosphoresce, yet no X-rays can be detected. Sometimes the phosphorescent light is local, occuring in spots here and there. It may be near the cathode or anode, or between them, or as in a tube



DETERMINING THE SOURCE OF THE X-RAY.

with which I experimented, the light was practically uniform on the whole surface, and a fluorescent screen was illuminated by all parts of the Crookes tube equally. Experiment also shows that with a given Crookes tube, the penetrating power of the rays seems to depend upon the electromotive force of the electrical energy, all other things remaining the same. Tesla, with his apparatus, has projected them through the thickest part of the human body, so as to affect the photographic plate.

Upon first reading the statement of Prof. Röntgen as to the phosphorescent spot being the source, it occurred to me that phosphorescence by other means might also radiate X-rays, and I was anxious to learn in the most emphatic manner the truth of the matter, whether it ended in negative or positive results. I have, therefore, been carrying out a series of experiments to determine whether ordinary phosphorscence will produce X-rays. Although I obtained negative results, yet the conclusion should not be drawn to the effect that X-rays may not be obtained by phosphorescence produced otherwise than by electricity, because by no possible means imaginable could I cause light to produce upon a Crookes tube the phosphorescence obtainable by the current, which, as well known, is visible even by daylight. Parenthetically, the intensity of light spoken of in text books is a misnomer. The light considered as to its penetrating power at the focus of the lens is no more intense than elsewhere. It will not penetrate anything to any greater distance by being condensed. It merely appears brighter to the eye, because there is more of it upon a given area, or because more of it has penetrated a given substance. The volume alone is greater.

To determine the degree of phosphorescence obtainable upon a Crookes tube by direct sunlight, it was placed inside of a box having an opening covered by violet glass. When the box was looked into, so as to exclude all other light the tube did not even appear green. However, under the same circumstances, uranium glass, barium platino cyanide, also a screen of ammonium uranate, potassium platino cyanide and others, each appeared of a vivid green or yellowish green. The experiment was repeated with focused sunlight on a very large scale, the lens being about five inches in diameter and having a focus of sixteen inches, and provided also with a funnel, white inside, which brought to a focus much diffused sunlight. The small end of the funnel was located in a dark room. The light was condensed upon violet glass.

The light passed through the glass, and, upon striking the phosphorescent and fluorescent materials, its refrangibility was changed; while the substances were as vividly green as when produced by the radiations in the Crookes tube, and, light cannot cause the same phosphorescence upon a Crookes tube did not become green. Uranium glass seemed as bright as when forming a Crookes tube highly charged. The Crookes tube had been before tested, and showed a green phosphorescence with a high electromotive force. The experiment with violet glass, although perfectly simple, and although the results, perhaps, could have been conjectured, proves that sunlight cannot cause the same pohsphorescence upon a Crookes tube as that produced by the current.

Another experiment indicated somewhat otherwise. In the direct focus, without blue glass, a livid green (as when electrified) was discernible as a fringe around the focus.

Inasmuch as the other substances fluoresced better with the violet light than with the electrified Crookes tube, as far as the eye could remember, an experiment was performed with the apparatus shown in the accompanying diagram, in order to determine whether condensed sunlight would produce sufficient phosphorescence for the generation of X-rays. The funnel above described was closed at the small end successively by different phosphorescent and fluorescent substances, b. The instrument which has now become known as the fluoroscope was directed towards the substance, b; which was made phosphorescent or fluorescent by the condensed sunlight, d, in order to detect fluorescence upon the screen, e, within the fluoroscope, which was covered at the large end partly with one thickness, b, partly with two thicknesses, and on another portion by three thicknesses of black paper.

The fluorescent screen, f, appeared green only at the part covered with one thickness. It was brighter without screen, b, which seems to contradict Niewenglowski's result. If there had been X-rays of any appreciable extent, they would have caused fluorescence through the three thicknesses and through a block of wood, g, interposed between the two fluorescent screens outside of the fluoroscope, as illustrated in the diagram. It should be noticed that the fluoroscope was exceedingly sensitive, and yet the results were negative.

The same instrument was tried with a Crookes tube generating X-rays by a current, and it became uniformly luminous at a distance of six feet from the electrified Crookes tube; therefore, it may be concluded, I think, that X-rays cannot be obtained from phosphorescence produced by sunlight. It may be noted that the objects were not placed exactly in focus because they would burn. The funnel, a, was cut off so that the cross sectional area of the path of the condensed rays was about one-fourth of an inch in diameter, and in this case heat absorbing substances were not needed further than that of the lens itself.

Aluminum was substituted for the block of wood, g, but no fluorescence occurred with the fluoroscope. The experiment was modified in a great many different directions; for example, by using the focused light when reflected from the screen, b, although (as the latter was made of a mixture of pulverized fluorescent material and varnish) the fluorescence was caused by reflection from each particle when the light was transmitted by the screen, as well as when reflected therefrom. A gas flame was also employed as a source of light; also sunlight without a lens.

Remembering how a little daylight entering the eye while viewing fluorescence by X-rays nearly neutralized the effect, I thought, perhaps, persistence of vision prevented my seeing any fluorescence which might have been produced through the three thicknesses of black paper, and therefore I applied the most severe test. A photographic plate with a metal ring attached to it was wrapped closely in several folds of black paper and inclosed in an aluminúm box, which, in turn, was wrapped in cloth. On the outside of all was fastened a plate of uranium glass, which was exposed to direct sunlight for over seven hours. No effect whatever was produced upon the photographic plate. With X-rays, an effect would have occurred through the same thickness in a few minutes.

A large glass plate covered with calcic sulphide, which remains luminous in a dark room after having been exposed to sunlight, was tested. I exposed the plate to the condensed sunlight, forming a bright, luminous spot, and at another time I exposed the whole plate to sunlight for an hour or more. When the fluoroscope was directed toward it in the dark and certain experiments performed, sufficient light was produced

to illuminate the screen in the fluoroscope, but not through even a single thickness of black paper, but only enough to cast a shadow. Here again the bluish brightness of the luminous paint is not visible in daylight, while a Crookes tube energized by electricity radiates green light abundantly and is easily visible in daylight.

While these experiments do not prove that the X-rays do not have their source alone in the phosphorescence of a charged Crookes tube, yet they form substantial evidence that X-rays are not obtained from phosphorescence by sunlight.

ON THE SOURCE OF THE ROENTGEN RAY.

BY

W. M. Stine

A series of experiments extending over the past six weeks has at length yielded conclusive evidence and enabled the source and distribution of the ray to be mapped out around the entire tube with great clearness. Penumbral shadows were repeatedly plotted back to the tube and invariably pointed to

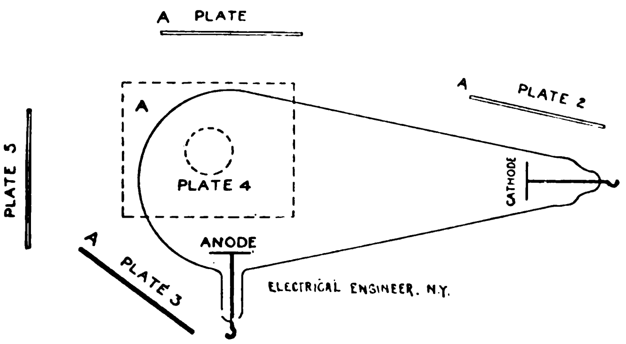


FIG. 1.

the area of the bulb opposite the cathode as the source of the distribution. These observations have already been published.[1]

It occurred to the writer that the best means to trace the ray distribution would be shadows cast by short metallic tubes. Half-inch lengths were cut from No. 18 gauge brass tubing, varying in diameter from ½ inch to 3 inches. In the first experiment, these were placed concentrically on a dry plate and placed parallel with the bulb in position marked 5 in Fig. 1,

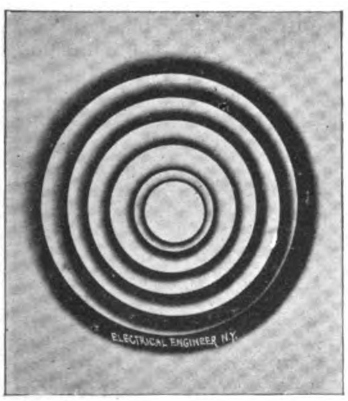


FIG. 2.

the distance of the plate from the bulb being 4 inches. The sciagraph is reproduced in Fig. 2.

Two separate effects are to be noted in all the sciagraphs of the tubes used. Both the length and direction of the shadow are clearly indicated and the vertical shadow of the metal itself. It will be noted that the latter seems to indicate the presence of rays which are more or less vertical. Plotting the shadows in Fig. 2 and noting that the vertical shadow does not appear beyond the third ring, we find that the source of the rays was on the surface of the bulb, and the area of the source was nearly or quite circular, and not much in excess of the diameter of the third ring, which was 1½ inches.

With such a clear and unmistakable result in possession, the next experiment was an attempt to decide whether this area was the only source of the ray. We were guided in this by some recently published emphatic statements that the ray was of anodic origin and did not, as popularly supposed, proceed

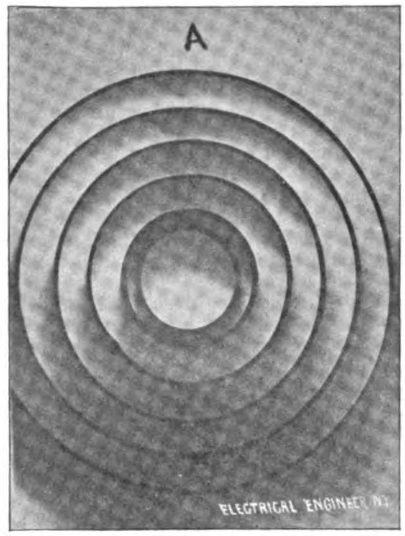


FIG. 3.

from the cathode. It was seen that while a screen could be misleading, the shadows cast by rings would be conclusive. Four plates were prepared for simultaneous exposure. The concentric rings were placed on one plate, and single rings, of 1 inch diameter and same height, were placed over the other plates. All these objects were placed as nearly as possible on the center of the plate. In Fig. 1 is shown the shape of the tube, the position of the electrodes and the plates, which were 3¼ by 4¼-inch in size, and placed 2½ inches from the bulb. The plates were marked with the letter "A" on the ends which were disposed as shown in the drawing. The resulting sciagraph from plate 1, is shown in Fig. 3, that from plate 2 in Fig. 4, from plate 3 in Fig. 5, and from plate 4 in Fig. 6.

To interpret the results, note first the sciagraphic effect of the rings, and second, the elliptical shadows of the intercepted inclined rays. If the latter be plotted, they all point to one area, the circular cathode imprint on the end of the bulb. We may now call this the prime source of the Röntgen ray. The vertical ring shadows, however, indicate numerous secondary and more or less weak sources. A general statement can then be made to the effect that about the entire surface of the tube is sciagraphically active. The four plates were developed to-

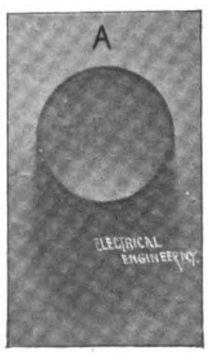


FIG. 4.

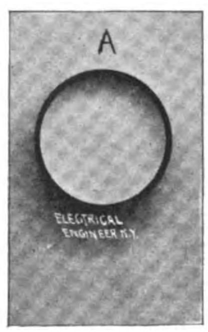


FIG. 5.

FIG. 6.

gether for an equal length of time. Plates 1 and 3 developed soonest, 4 a little slower, and the image on 2 was the last to appear. The resulting negatives are, however, all excellent and of about equal density. It is thus shown that a number of sciagraphs may be taken simultaneously if the entire tube be surrounded by plates. It might be added that the rings in Fig. 3 were held in concentric position with wedges of pine wood one-half inch thick, and since these do not show, they were entirely transparent for this length of exposure.

1. "Western Electrician", Mar. 7, p. 110 "Electrical Engineer", Mar. 11, p. 225.

The sciagraph shown in Fig. 3 is now, perhaps, the most interesting one of the series. It was purposely placed exactly opposite the anode. If the anode were the source of the ray, the resulting sciagraph would have resembled the one shown in Fig. 2; all the shadows would have been concentric rather than elliptical. The result plainly shows that the cathode, not the anode, is the source of the X-ray. The polarity was determined by testing the charges on the poles by means of an electroscope. In Fig. 5, plate 3, the shadow points only in one direction, and since the ring was near the anode, it would have shown a shadow on the opposite side had the anode been active. Fig. 4, plate 2, shows another striking result. The shadow is seen to broaden as it extends from the ring. This indicates that the rays crossed between the source and the object. The explanation is at once apparent. The rays were, in a sense, focused by the concave surface of the interior of the bulb, but it must not be concluded that the Röntgen ray has thus been actually focused.

If Figs. 3, 5 and 6 be carefully examined, the vertical shadows will be seen to be quite distinct, and Fig. 4 shows the same result less strongly marked. These phenomena are closely associated with the fluorescent appearance of the tube, which is decreasingly marked toward the space around the cathode.

The entire experiment here described has been carefully repeated, to avoid error. To summarize, it shows that there is but one marked source of the ray, that portion of the bulb opposite the cathode, and that the entire surface of the bulb is more or less a weak secondary source; that it is the cathode, and not the anode, which produces the rays. The only question which now remains is whether it is the interior or exterior of the tube that is active. There are many reasons which point to the interior surface. Another tube has just been designed to test this point. However, it would seem that the active surface would be that struck by the charged molecules. These experiments have been largely directed by the electrolytic theory of the production of the sciagraph which has been advanced by the writer.

The tube used in these tests was one especially designed to promote electrical exhaustion. The writer has advanced the opinion that this was accomplished by the occlusion of the gas by the anode. The vacuum of the tube was too low to produce the sciagraph when first tested, but after being excited for about ten hours became quite active. If, however, the current is reversed, the tube immediately fills with the purple light at first present. This seems quite conclusive evidence and further shows that no material particles are projected through the walls of the tube.

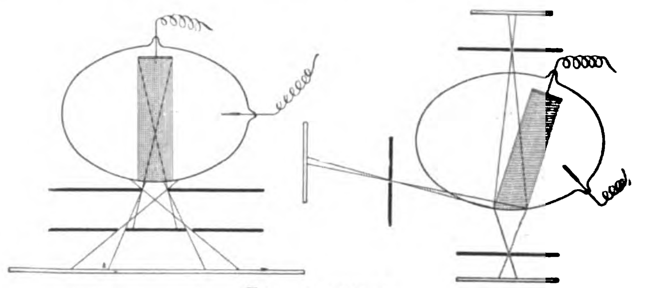
THE SOURCE OF THE X-RAY.

BY C. E. SCRIBNER AND F. R. M'BERTY.

IN an effort to locate the source of the X-ray in the Crookes' tube, the following experiment was made: Immediately beneath the bulb was placed a screen of lead, thick enough to be nearly opaque to X-rays, with a circular opening one inch in diameter immediately under the bombarded spot of the bulb; 2½ inches below this diaphragm was placed a second screen with two openings of one-half inch diameter, located so far apart that any ray passing directly from the cathode plate through the first aperture would be intercepted by the second screen. Below the second screen was placed a photographic plate. The arrangement is represented in Fig. 1.

A short exposure and developement of the plate brought out two densely black elliptical spots on the plate.

Referring to Fig.1, if the X-ray had proceeded from the cathode alone, in straight lines therefrom, no image would have been produced on the plate. The ray must have proceeded from some point in the tube far below the cathode to have reached the plate at all. The dimensions of the apparatus and the spots on the plate were accurately measured, and were plotted out to scale in the way frequently used in optics. Straight lines carried from the edges of the black spots at the edges of the screen, located the source of illumination at the wall of the bulb. Moreover, the illuminated spots on the plate showed strongly illuminated central discs surrounded by less sharply illuminated parts, such as might be expected



FIGS. 1 AND 5.

to be produced by a source of radiation of considerable area acting through such a system of screens.

This experiment seemed to demonstrate that the ray did not proceed from the cathode alone, unless it was diffused in all directions from the wall of the tube at the point of bombardment. It of course did not differentiate between rays actually proceeding from the glass, and rays which might proceed from matter in the same line within the bulb. In the same experiment a pin-hole image of the bombarded spot of the bulb was obtained through a very small hole in the second screen.

Immediately following this experiment, acting upon the hint obtained in it, a number of pin-hole images were taken of different bulbs, the upper screen being absent. In a pin-hole photograph any source of X-rays within the bulb, or on any portion of the wall of the bulb, would necessarily produce its image on the photographic plate below. In every case, however, the image on the plate was solely that of the fluorescent portions of the bombarded spot. The image corresponded in size, form and position with the utmost exactness to that which would be expected from the optical construction, on the assumption that the source of illumination was at the inner wall of the bulb. It was larger than the actual spot in the bulb when the distance from the wall of the bulb to the screen was less than that from the screen to the photographic plate, and smaller under the reverse condition.

No image was obtained in any case of any spot or object within the bulb other than the bombarded spot opposite the plate serving as cathode. The image did not even include the diffusely fluorescent yellowish streaks radiating from the bombarded spot or flickering about the walls of the bulb. Of course with a current which converted the two electrodes alternately into cathode and anode, two spots of bombardment would be obtained.

Figs. 2 and 3 represent two pin-hole photographs of different

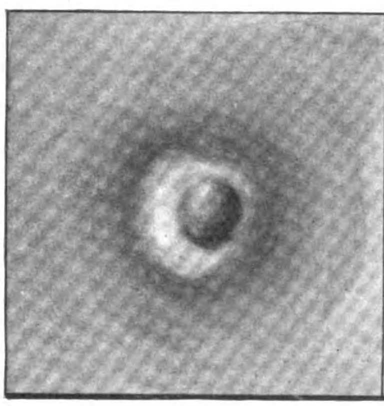


FIG. 2.

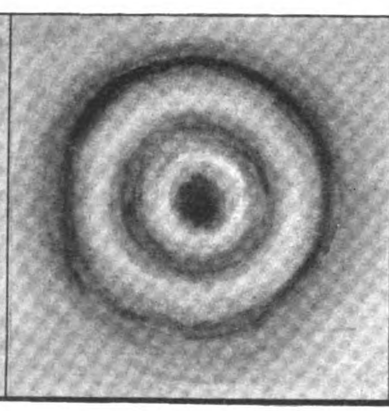


FIG. 3.

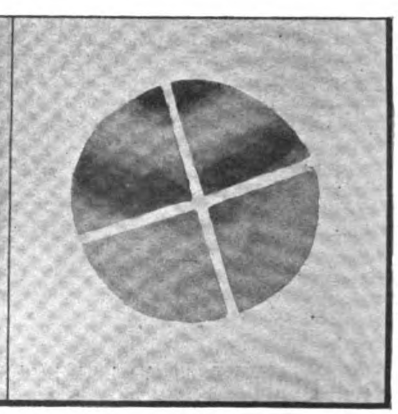


FIG 4.

bulbs. The bulb used in making Fig. 2 had a plain disc of aluminum as cathode. That used for Fig. 3 had a cathode made up of a central small disc of platinum surrounded by a ring of aluminum. The bright lines in the bombarded spot and in the images do not correspond to broad surfaces of the cathode, but to edges or raised portions. These figures are made from India-ink drawings copied from the negatives as faithfully as possible, on account of the unsatisfactory character of prints taken from the negatives themselves. The negatives of course present the shadings with greater delicacy and evenness, and the outlines more distinctly.

It will be remembered that Professor Röntgen, in his announcement of the discovery of the X-ray and its attendant phenomena, mentioned that when the stream of radiant matter is deflected by means of a magnet, the X-ray proceeds from the new spot of bombardment. This proposition of Professor Röntgen has been abundantly confirmed by means of the pin-hole photographs. Beneath the bulb the image of whose bombarded spot is represented in Fig. 3, was placed a diaphragm with a one inch aperture having a pair of lead cross wires extending over the aperture and crossing at its center. The point of crossing of these wires was located immediately under the center of the series of concentric rings which constitute the source of X-ray illumination in that bulb. Beneath the diaphragm carrying the cross wires was placed the usual diaphragm with a pin-hole aperture, and below that the photographic plate. When all was in readiness the stream of radiant matter, and consequently the spot of bombardment in the bulb, were deflected by means of a powerful electromagnet, so that the second bright ring crossed the center of the cross wires. After a long exposure the plate was developed; the image showed the shadow of the cross wires, and the rings which constituted the source of X-rays lying eccentrically upon them, the most strongly illuminated band—that which appeared blackest on the plate—crossing the center of the cross wires. The source of X-rays had been displaced to a different part of the bulb by the electromagnet, namely, to the new spot of bombardment. The image is shown in Fig. 4.

A similar experiment was made to determine whether the ray itself could be deflected. The magnet was placed to act upon the pencil of X-rays near the photographic plate, at such a distance that the action of the magnet did not produce any appreciable displacement of the stream of radiant matter, but that it would tend to produce a considerable displacement of the image upon the plate if the ray should be susceptible to its action. The plate was exposed with the magnet unexcited for twenty minutes, and then subsequently with the magnet excited for twenty-five minutes. If the image had been displaced by the magnet, two like images in different positions should be found upon the plate. As a matter of fact, but one was found, and that in position to indicate that the magnet was of no effect in displacing the pencil of rays outside the bulb.

The evidence of single pin-hole images of the different bulbs would seem to furnish sufficient grounds for the assertion that the X-ray proceeded only from the bombarded spot at the inner wall of the tube opposite the cathode. A further experiment was made, however, which is conclusive on this point. Three pin-hole images were taken simultaneously of the same bulb. One plate and diaphragm were arranged to view the bombarded spot from immediately below. Another plate and diaphragm were placed at the side of the bulb. A third plate and diaphragm were placed above the bulb, in position to look down directly upon the bombarded spot. A special bulb was made having its cathode placed in a somewhat oblique position so that the bombarded surface might be visible from a point in a line perpendicular to it outside the bulb, without obstruction by the cathode. The arrangement is represented in Fig. 5.

When these plates were developed after a long exposure, the lower plate was found to contain the usual image of the bombarded spot at the bottom of the bulb. The plate at the side contained an inverted side elevation of the same spot. The upper plate also contained an image of the bombarded spot at the bottom of the bulb. On none of the plates was there any other image whatever, although each plate was exposed to the whole bulb. The small spot at the bottom of the bulb at the point of bombardment, on the inner wall of the glass, was the only point about the bulb from which any X-rays proceeded.

The images also tended to show that the source of the ray was at the inner wall of the bulb. If it had been at the outer surface, there would have been no glass in the path of rays to the lower plate, and two thicknesses of glass in the path of those to the upper plate; hence the image on the former plate would have been much stronger than that on the latter. If the source were at the inner wall, equal thicknesses of glass would be in the paths of rays to the two plates. The images were of such depth of shading as to show that the plates had been equally illuminated, allowing for the difference in distances between the spot and the plates. No more definite experiment than this seems possible.

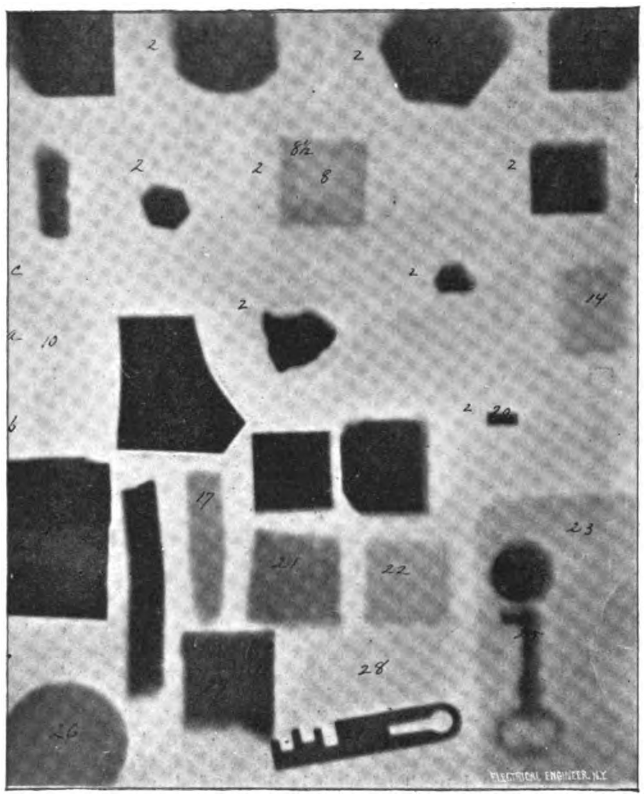
These pin-hole photographs were made at different times between February 20 and March 15, the first described experiment having been made at the earlier date, the last described demonstration about the latter date; the experiments were reported at a meeting of the Western Branch of the American Institute of Electrical Engineers on March 25.

From all knowledge which we have been able to gain of the numerous experiments with X-rays, we believe these experiments were the first to locate the source of the X-ray; as respects at least the large number of tubes which we have used, they located the source accurately and conclusively. So far as we can learn also, no other pin-hole images of bulbs have been taken, excepting perhaps the one which Professor Röntgen thought he had obtained. This mode of photographing promises excellent results in investigations as to the relation of the X-rays to the cathode discharge.

AN X-RAY PHOTOGRAPH OF VARIOUS SUBSTANCES.

We have received from Professor N. M. Terry, of the Physical Laboratory at the United States Naval Academy, Annapolis, a photograph taken by means of the X-rays, which we reproduce in the accompanying engraving. The number and variety of the substances embraced in it form an excellent means of comparison. The photograph was obtained by an exposure of 30 minutes with a Carbutt plate (26), with a pasteboard cover between the plate and the objects. The numbers designate the following substances:

1. Rock salt, 0.6 inch thick. 2. Cork, 0.4 inch thick. 3. Quartz, 0.45 inch thick, cut parallel to optic axis. 4. Verre trempe, 0.4



Roentgen Ray Photograph by Prof. N. M. Terry.

inch thick. 5. Glass, 0.7 inch thick. 6. Chalk. 7. Iceland spar. 8. Mica, very thin. 9. Quartz, over a square piece of glass. 10. Aluminum foil; (a) four thicknesses, (b) two thicknesses, (c) one thickness. 11. Platinum foil. 12. Tourmaline. 13. Aragonite. 14. Paraffine, 0.4 inch thick. 15. Tinfoil; (a) one thickness, (b) two thicknesses, (c) three thicknesses. 16. Rubber insulated wire. 17. Electric light carbon. 18. Glass, 0.32 inch thick. 18. Alum, 1.4 inch thick. 20. Tourmaline. 21. Gas coal. 22. Bee's wax. 23. Pocketbook, 10 thicknesses of leather. 24. Coin in the pocketbook. 25. Key in the pocketbook. 26. Machine oil in ebonite cup. 27. Ebonite, 0.25 inch thick. Other samples have given very faint shadows like wood and leather. This was polished. 28. Wood, 0.2 inch thick. 29. Steel key.

PLAIN IRON CONDUIT.

BY A. E. DOBBS.

WHY cannot plain iron pipe be used in a conduit system? Are the insurance men afraid that it may be burnt out? A half-inch iron pipe would surely have as much carrying capacity as any two wires that could be drawn into it, and in case of trouble on account of being confined in such a small

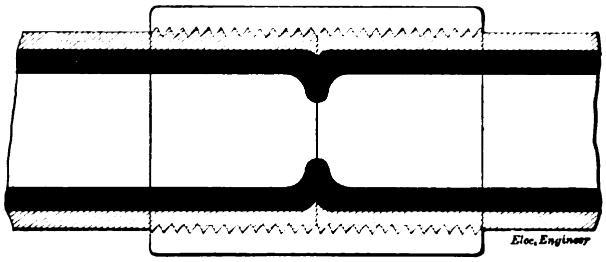


FIG. 1.

space, the low resistance of the arc should be able to melt them down without doing the pipe any serious injury.

A reamer pushed through the pipe would remove all fins, and burrs could easily be removed from the ends. By dipping it in hot asphaltum the tendency to sweating would be removed. The conduit people surely have to ream out their pipes, and if a contractor should demand a smooth asphaltum-coated pipe it would surprise him to find how many firms could furnish it to him at short notice.

But then there is the thought of a possible careless workman. But can one name a business that does not possess that class? Responsible contractors generally have foremen who are familiar with their methods and wishes, and to whom they can entrust the supervision of their work. Occasionally a projection may cut the insulation of the wire, but so also does iron armored conduit if the ends are not carefully reamed, as shown in Fig. 1, which is no fancy sketch. Every wireman knows that under these conditions a certain pitch or angle of these raised ends will strip the insulation like a knife. Of course Fig. 1 is an example of careless work, but iron armored conduit is not condemned on that account.

The rules of the National Board of Fire Underwriters seem to be a little inconsistent on this point. They first state that "The object of a tube or conduit is to facilitate the insertion or

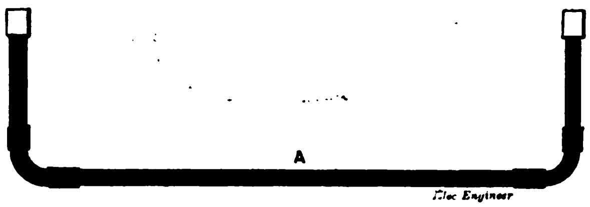


FIG. 2.

extraction of the conductors, to protect them from mechanical injury, and, as far as possible, from moisture. Tubes or conduits are to be considered merely as raceways, and are not to be relied upon for insulation between wire and wire, or between the wire and the ground." This is admirable, but in the rules that follow, conduits seem to be regarded especially as to their insulating qualities, and an insulation of one megohm for each ten-foot length of pipe is demanded, and in treating of other kinds of conduit, their insulating qualities seem to be referred to instead of their raceway function.

Suppose again, as in Fig. 2, which shows a pipe running from wall to wall under the flooring, which is often the case, that water should get into the pipe, and, of course, settle at A, which has happened more than once. In a plain iron pipe, as the room gets warmed up, the water would evaporate and leave the wire dry, while the paper tube used in iron armored work swells, gets pulpy, and in cool spots remains so for weeks. Another thing about iron armored conduits not considered by inspectors, but an important consideration with contractors, is its bulky size. Figs. 3 and 4 show the difference between a ⅝-inch armored and a plain conduit. It will be seen that the armored conduit is more expensive on account of its larger size, the labor required in putting it in place, and in many places the wall has to be channeled, where the smaller pipe has to be plastered in. In order to economize, the contractor uses pipe of the smallest possible diameter, often using a ⅝-inch pipe where a ½-inch should be, and duplex wire with a very thin covering, in fact, so thin that the insulation between wires cannot be very high.

Now, it seems strange that insulation in the wires should be sacrificed to secure insulation in the pipe itself, though it has always seemed absurd that insurance men should be so careful to secure insulation in conduits and at the same time insist on the best rubber covering for the wire. This is on a par with their requirements as to concealed work. Here the wire must be kept away from the woodwork and be carried upon porcelain insulators and cross joists through porcelain tubes so that bare wire would still be safe; but must at the same time have the best of insulation on the outside. When a man engaged in railroad work, for example, used to seeing wires no better than those used in house wiring—and having 500 volts difference between them—thrown around in bunches upon the floor of the car under the seat, crossing iron braces and crossing underneath the car in bunches of four or five, exposed to mud and slush, with only a thin cotton hose for protection, he is apt to wonder at the restrictions thrown around house wiring. But of course car wiring is readily accessible and is subject to constant inspection; but it gives so very little trouble that the wiring in most cars is not disturbed for years, except at the ends, when controllers or motors have to be repaired.

Things like these excite in the practical man somethink like disgust at the rules formulated by experts, but then, of course, house wiring contractors of the baser sort have to be closely watched, and the long list of rules was not provoked by the

FIGS. 3 AND 4.

work of reputable contractors. From the expert's point of view, the best is none too good, but from the contractor's point of view we must adapt our work to the financial resources or inclinations of our patrons, and it is notorious that each new set of rules means decreasing profits. The time when the electrical contractor was looked upon as the peer of the opulent plumber or coal baron has gone by. Insurance men would like to have nothing but fireproof buildings erected, but the financial limitations or inclinations of the people have led to the putting up of wooden buildings all over the country.

Underwriters should, and I believe are, trying to make wiring methods as simple and accessible as possible, and I believe that under proper restrictions they would find plain iron pipe a help in that work, for the reason that a great deal more conduit work would then be used than at present, and I believe plain iron pipe would be a better protection for the wires than some of the conduit tubes now on the market.

For wooden buildings I would propose that ordinary circuit breaker buttons should be stapled to the side of the joists and wire pulled through them (Fig. 5) and in going through the joists or studding, short porcelain bushings, not smaller than ⅝-inch on the inside, or a flexible tubing fastened between the lath; two or three turns of tape will hold it up tight enough at the outlets; the wire does not need to be drawn taut. Such a circuit can be pulled out for inspection or repairs at any time and is cheaper than conduit. The Seely insulator (Fig.

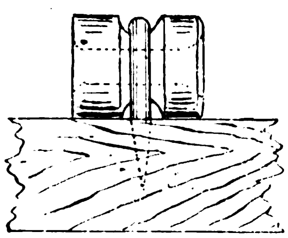


FIG. 5.

FIG. 6.

6), has lately, in accordance with a previous suggestion ("The Electrical Engineer," Aug. 7, 1895, p. 128), been covered with a silicate glazing and would doubtless be approved by the inspector.

The restrictions I would throw around plain iron conduit would be: 1. That the interior should be perfectly smooth. 2.

That all burrs at the end should be reamed smooth also. 3. That the interior should be given a coating of asphaltum paint. 4. That wires should be of the standard prescribed by rules 12 and 18, which provides that wires "must be solid at least 3-64 of an inch in thickness" and covered with "substantial braid," etc. Duplex wires in this conduit should be forbidden, as experience has shown that they are more liable to make trouble than two single wires drawn in together. 5. That no pipe smaller than ½ inch inside diameter be allowed; this would remove the temptation to use wire with thin insulation.

This article was not written for the purpose of finding fault with iron armored conduit—which is the best thing now on the market—but for the purpose of enabling contractors to make some money on their work. While prices of material are falling all the time, electric work seems to be getting more expensive and less remunerative. Many men who have made a study of this subject feel that the business of house wiring is not yet standardized and that present rules and methods are only temporary. We may yet hope for concentric wiring, but that subject demands another paper.

APPARATUS OF THE ROYAL ELECTRIC COMPANY OF PEORIA, ILL.

One of the electrical manufacturing companies which have more than held their own, are the Royal Electric Company, of Peoria, Ill. This company, conducted on a very conservative financial basis, have weathered these several years of financial stringency and hard times in a comparatively easy way, and have done a very comfortable business.

Their apparatus, for which there has been a steadily increasing demand, offers special features and advantages, which are the cause of the perfect satisfaction they give wherever used. We refer in particular to their alternating current system, which has stood the test of time in practical use.

The alternator, which is shown in its complete state in Fig. 1, is of the inductor type. It is mounted on a solid frame with proper provisions for tightening belts. The ample bearings are of the self-oiling type, and are provided with oil gauges. The exciter terminals, as well as the high potential current terminals, are shown mounted centrally on top of the machine. To the right, we find the driving pulley for the alternator; to the left, that for the exciter. The construction of the field magnet is specially noteworthy. It consists of a tube, Fig. 2, surrounded by a single field magnet spool. The latter is attached to the frame work, and is stationary. Around the spool is located the spider on which the laminated core pieces constituting the armature core, are mounted. Four projections of the spider are visible in the view shown; they are extensions to which the central tube and the field magnet coil are secured by means of screws. The others are covered by the laminations of the armature iron. At the two extreme ends of these laminated blocks, are mounted two sets of coils which constitute the armature winding.

The coils on each side are generally connected in series, and each produces in the standard machine 1,000 to 1,100 volts. Connecting all the coils on both sides in series will evidently make the machine a 2,000-volt machine; on the other hand, a subdivision of the coils will enable the same machine, without change of coils, to be reduced to 500 volts, 220 or 110 volts for low tension alternating current work, without the use of transformers. Owing to the position of these coils at a place where they do not interfere with the rotary parts, or increase in any way the magnetic circuit, it is evident that plenty of space can be used for properly insulating the coils. This has been taken advantage of in this machine, and in utilizing it for high tension work no step-up transformers are recommended with the machines, not unless the potential rises above 5,000 volts. This construction of field coils and their position offers a great many advantages; and in case a coil should be damaged by accident or lightning, it will be readily seen that the injured coil can be cut out without difficulty and be replaced in a very short time. As they are not inclosed, they are capable of quickly radiating the heat produced in them, and are therefore capable of keeping considerably cooler than similar windings, carrying the same amount of current in other designs.

Heretofore it has been customary to have a separate armature on hand with nearly every machine, but the Royal Electric Company supply an extra coil or two with a new machine, which has proved to be all that is necessary as a safeguard. The cross section of the armature coils is so calculated that the energy wasted in them is a very small percentage, and close regulation is insured.

The rotating part of the machine consists of a central wrought iron core part, with two end plates which have the shape of a star, in such a way that alternate coils are covered by them. Intermediate spaces are blocked to prevent unnecessary air grounds.

Tests made on these machines disclose that the excitation required for them is lower than that of ordinary alternators, and that the energy is about one per cent. of the output of the machine, and in some cases less. This type of machine is primarily an alternator, but it has this further advantage that the circuits of the two sides can be operated independently from one another, and can be arranged to produce two separate currents whose phases are 90 degrees apart. Central station owners would have, therefore, the advantage of not requiring a new machine, should they desire to put two-phase motors in the circuits of the machine. In most types this cannot be accomplisheu. These machines are thus far built up to 2,000 lamp capacity, and larger sizes are in the course of construction.

Besides the various accessories which make a system complete, and which are carefully worked out by the company, we wish to mention their transformer, which also has certain points of merit and advantage. It goes without saying that a transformer nowadays should be efficient, close regulating and have but small internal losses. These are features which are claimed by the transformer of the company. In the latest form shown in Fig. 3, they provide special means for protecting the transformer, as well as the lineman, by primary fuses

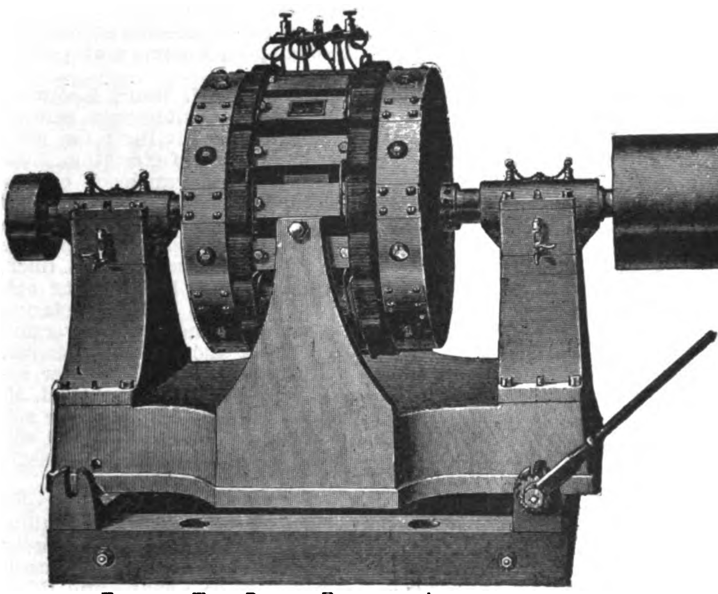


Fig. 1.—The Royal Electric Alternator.

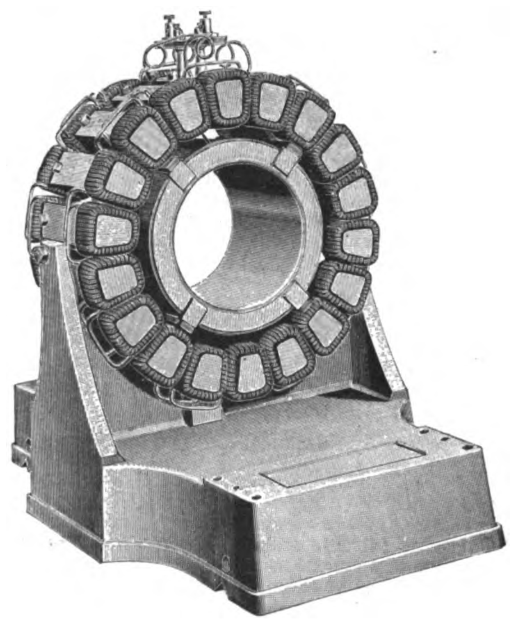


Fig. 2.—Royal Electric Alternator.

which are covered by a spherical shaped projection, visible on the face of the transformer box. They extend from the front to the back. These fuses are mounted on cylindrical plugs which are provided with insulating handles projecting outside of the case. They are protected in a weather-proof manner by the spherical shaped cover just mentioned. These two hollow shells form a single casting, and are held in position by a centrally placed thumb-screw, which, when released, gives access to the fuse plugs; but the thumb-screw is so constructed that it is impossible to remove the shells bodily from the casing. In all the various details of construction, special care is

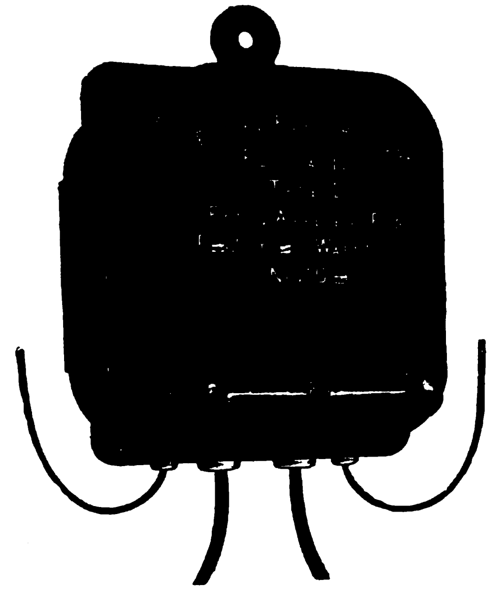


FIG. 3. ROYAL ELECTRIC CONVERTER.

taken to guard against danger, and to provide proper means for protection and insulation.

With the careful management on the commercial end of the business, as well as the pains taken for safety and stability of construction in the manufacturing end, we have no doubt that this company will do a rapidly increasing business. The officers of the Royal Electric Co. are: Ferd. Luthy, president; E. B. Hillman, vice-president; G. T. Page, secretary and treasurer; G. Luthy, manager; G. G. Luthy, assistant manager.

AN ANALYTICAL STUDY OF THE ALTERNATING-CURRENT ARC.[1]

THE first part of the paper consists of an analytical study of the distribution of light throughout the various radiating regions in the arc when supplied with electric power of known constant amount, the periodic variations of the current through the arc and of the potential difference between the carbons being at the same time recorded. The power was measured by means of a bifilar wattmeter, while by means of a series of mirrors and a rotating disc carried by a synchronizing alternate-current motor, the mean value of the light taken from any part of the arc was compared with the instantaneous value of the light taken from the same part of the arc, and taken at any assigned instant during the period. Thus the arc itself was its own standard, and difficulties due to slow variations in the mean light of the arc disappear. The facts observed may be summed up as follows: The purple light of the true arc undergoes a periodic variation, and, as far as the eye can judge, is completely extinguished during a certain interval during the phase; it has equal maxima values during the period, at instants slightly lagging behind the instants of maximum power expenditure in the arc. On the other hand, the illuminative power of the carbon crater varies between a minimum value and two unequal maxima, the greater maximum occurring when the carbon is positive, and at an instant slightly lagging behind the instant of maximum power expenditure in the arc. The second part of the paper consists of a comparison of the efficiency of the alternate-current arc regarded as a light-giving agent as compared with that of a continuous-current arc taking the same mean power. Using two arcs, which may be regarded as typical of those used in practice, the mean spherical candle-power was compared for equal expenditure of power in the arcs, and it was found that for the alternating-current arc employed, the total mean spherical candle-power was always less than that of the continuous-current arc. Lowering the frequency seems to decrease the efficiency of the alternating-current arc.

[1] Abstract of a paper read before the London Physical Society by Prof. J. A. Fleming and Mr. Petavel.

X-RAY EXPERIMENTS.

THE "Comptes Rendus" continues to present the result of the work of a number of French experimenters on the X-rays. In its issue of March 2 M. D'Arsonval describes experiments, which he sums up as follows: "All bodies giving rise to greenish-yellow fluorescent radiation can impress photographic plates through opaque bodies. It follows that the rôle of cathode rays in Röntgen's experiments would appear to be limited to fluorescing the special kind of glass of which the Crookes tubes are composed." M. Henri Becquerel in the same number refers to his previous brief announcement of experiments, showing the existence of invisible radiation emitted by certain phosphorescent substances and passing through bodies opaque to light. Such radiation is emitted by strips of the double sulphate of uranyl and potassium. MM. A. Imbert and H. Bertin-Sans make a communication on "The Diffusion of Röntgen Rays." They find that within the limits of their experiments Röntgen rays are regularly reflected to only a very slight extent; on the other hand, they may be much diffused, and the "intensity of the diffusion appears to depend much more on the nature than on the degree of polish of the diffusing body. A fact which tends to show that the new rays have a very small wave length such that it is impossible for us to attain the degree of polish necessary to cause regular reflections. The clichés obtained by us reveal, moreover, in quartz and cork different degrees of transparency in regard to the rays diffused by the different bodies used." MM. Bleunard and Labesse have a note on "The Passage of Röntgen Rays through Liquids." They state that water is very transparent, and, as has been previously observed, they find that color has no perceptible influence. Solutions of bromide of potassium, chloride of antimony, bichromate of potash, offer "a somewhat considerable resistance to the passage of Röntgen rays." Solutions of borate of soda, permanganate of potash, are less resistant.

In the "Comptes Rendus" for March 9, M. Henri Becquerel describes further experiments with the invisible rays emitted by phosphorescent bodies, which do not emit light for more than about 1-100th of a second after cessation of excitation. Electrified bodies are discharged. Using an Hurmuzescu electroscope, which, protected against electrical influence by a metal case and against ultra-violet light by yellow glass, can retain its charge for months, M. Becquerel found that on replacing some of the yellow glass by a strip of aluminum 0.12 mm. thick, and applying a strip of the phosphorescent body to the outside, a charge was dissipated in 2 hours 56 minutes; placing the phosphorescent body inside the case under the divergent gold leaves naturally resulted in their more rapid collapse. Experimenting with a view to discover how long after exposure to light these invisible rays continue to be emitted, M. Becquerel finds that with sesquioxide of uranium, double sulphate of uranyl and potassium, sulphate of sodium, and sulphate of ammonium, the power of the rays emitted is not sensibly diminished after 160 hours in the dark.

Amongst the many communications to the Académie des Sciences there is one dated Liège, Feb. 13, 1896, emanating from a M. de Heen, which commences as follows: "In order to take date, I have the honor of informing you that according to my latest experiments the X-rays of Lenard and Röntgen do not emanate from the cathode, but from the anode." Another communication of interest is one from M. G. H. Niewenglowski, in which he states that he has discovered that phosphorescent bodies have the same property of assisting the transmission of solar light as phosphorescent sulphide of zinc has in regard to Röntgen rays, a phenomenon which was recently pointed out by M. Chas. Henry. MM. Abbé Buguet and Albert Gascard, in a note in the "Comptes Rendus" of Feb. 21, state that the natural diamond is far more transparent to X-rays than the imitation variety, and the same holds good for natural jet. In the same issue MM. Darieux and de Rochas briefly describe some experiments made with the eyes of freshly-killed pigs, which go to show that the media of the eye, so perfectly transparent to light, are but very slightly so to X-rays.

ONE MORE UNFORTUNATE.

The electric light and water plant of Le Mars, Ia., will be sold April 15 to satisfy bonds of $23,290. The plant is valued at $150,000 and will be sold without redemption.

HIGH-VOLTAGE LAMPS AND THEIR INFLUENCE ON CENTRAL-STATION PRACTICE.[1]—I.

BY G. L. ADDENBROOKE M. I. E. E.

In the spring of 1891, which was the last occasion when the alternating vs. continuous current controversy came prominently before this institution, and when Mr. Crompton brought forward his feeder argument, I had the honor of opening the discussion, and subsequently continued the argument in the technical press, besides going into it privately with Mr. Crompton. I was not, however, convinced of the superiority of low-pressure direct supply, and on the old premises I remain unconvinced still; but I saw that the advantages of the two systems were in many cases very nearly balanced, and if one or other was ultimately to prevail it would probably be for some other reason than lay in the arguments which had so far been brought prominently forward on either side. It was, in my mind, useless to say that the two systems were each the best for certain situations, for how was the line to be drawn; or in some cases were we to have both systems in one town? Though a possible, this did not seem to me a desirable solution. The question is not merely an academic one. Hundreds of thousands of pounds are yearly now spent on electric lighting, and that a large portion of this sum should be spent in a way that is not the best and most permanent is a serious matter. Besides this, as a consulting engineer, I found my position an unpleasant one. What was I to recommend to my clients; and if I halted between two opinions, what would my clients think of me? I regret that in these matters I have not the assurance of some gentlemen, who, I understand, circularize all town councils, keep their own touts, and are prepared to give cut and dried verdicts without hesitation on engineering points which, I must confess, I approach with a certain amount of awe and misgiving, and a very serious sense of responsibility. Now, it struck me four years ago, as I daresay it did others, that as the two methods had been argued over so carefully without any definite conclusion being arrived at, probably some outside and fortuitous circumstance which neither side had taken account of would ultimately turn the balance one way or the other.

Possible Sources of Influence on Central-Station Practice.—I therefore made a careful survey of the field, and the only eventualities I could think of, or which seemed likely to have a very important bearing on the problem, were the following, viz., the introduction of (1) an altogether new form of lamp, (2) a cheaper material for mains than copper, (3) a high-voltage incandescent lamp, (4) a much more economical incandescent lamp of the present voltage, (5) an improved and much cheaper storage battery.

Respecting a new form of lamp: After having seen Tesla's experiments at the Royal Institution, and after having learnt privately the views of some of our leading investigators on the field which they opened, I must say, as a practical man, I did not see any immediate hope of a commercial success in this direction, however interesting the results might be scientifically. As regards the chance of a cheaper conductor being forthcoming, I have dealt with this question at length in a recent article in the London "Electrical Review." Owing to the cheap rate at which aluminum can be produced, and will increasingly be produced in the future, and since the conductivity of aluminum is 56 per cent. of that of pure copper of the same section, the chances of aluminum ultimately supplanting copper are strong, but the change will undoubtedly be a comparatively slow one. The possibility of this, however, points to a reduction in the price of conductors; and this, of course, would tell somewhat in favor of moderate pressures. Again, as even in moderate-pressure mains insulated with bitumen or other compounds the cost of insulating is twice the cost of the conductor itself in the sizes usually employed, it is quite conceivable that very important economies may be effected in this direction. It is obvious that improvements of this character would probably tell more in favor of moderate pressure than of high.

Having thus disposed of the conductor question, we come to the third and fourth alternatives I have mentioned as likely to influence central-station practice, viz., the introduction of a lamp of higher voltage, or a more economical lamp of the present current voltage. When thinking over the matter in 1891, I saw that, as fairly good lamps of 8 c. p. for 100-volt and 110-volt circuits were being made, two of them could be put in series, and that we should get very simply a 16-c. p. lamp of 200 to 220 volts. This, however, involved giving up 8-candle lamps except two in series, which, as the charge for current was then usually 8d. per unit, was a serious matter; and again, as there were two filaments in each lamp, the breaking of either of which would spoil the lamp, this also introduced an important objection, particularly as the Ediswan monopoly maintained the price of lamps at 3s. 6d. for ordinary voltages, and could hardly be expected to supply lamps which would be more expensive to make, except at an enhanced price. The prospect of obtaining high-voltage lamps did not, therefore, at that time appear bright. Time has, however, brought about great changes in the lamp industry, due largely to the expiry of patents, which quickly led to numbers of good lamps being placed on the market at less than one-third the price formerly charged, and at the same time brought active and pushing competitors into the field. Two years and a half ago, finding some disposition abroad to adopt higher voltages, I drafted an article pointing out the enormous gain which would accrue in the distributing system if higher voltage lamps were adopted, intending to send it to one of the journals. The question, however, then appeared somewhat problematical, and other business led to the article being put on one side. I did not, however, forget the matter, and last December year, finding that one or two firms were trying to introduce lamps of 200 volts, I looked over my draft again, and, having somewhat elaborated it, sent it to the London "Electrical Review." The article attracted the attention of Mr. Baynes, then of Bradford, and he wrote detailing his experience and the experiments he had made with high voltage. Since then the matter has advanced by leaps and bounds. Several lampmakers are undertaking to supply 16-c. p. lamps of voltages up to 230 and even above; and not only this, but Mr. Stearn and one or two other makers are offering lamps up to this voltage of 8 c. p. also, and guaranteeing a fair economy. The lamps are also being offered at moderate prices. Low-tension central-station engineers have not been slow to perceive the facilities these lamps offer. In some cases they have been adopted publicly, and in other cases private experiments are being made on them with satisfactory results. I also hear from those manufacturers who are catering for the market that the demand for high-voltage lamps is steadily and rapidly increasing. The adoption of these lamps is, of course, somewhat in the tentative stage, but so much progress has been made, and the results attained so far are so good, that no one can doubt that in a year or two they will become a permanent institution. It may also be noted here that since this paper was sent in I see that Professor Kennedy has considered the 230-volt lamp sufficiently sound to recommend the Town Council of Edinburgh to adopt it.

[1] Paper read before the London Institution of Electrical Engineers, Feb. 27.

FLAX STRAW AS FUEL AT WATERTOWN, S. D.

With regard to the use of flax straw as fuel in the electric light plant at Watertown, S. D., Mr. H. V. Peterson, manager of the electric light works, writes us:

"Our location here, so far from the coal fields of Iowa and Illinois, results in transportation charges being so great as to prohibit the use of coal in this business with profit. Soft coal will cost from $3.50 to $6.50 per ton on cars here for the various qualities, from Iowa slack to the high-grade Eastern coals; and wood ranges from $3 per cord for soft wood to $4 for hard on cars. We can buy flax straw in abundance delivered at the plant for $1 per ton, and consider that two tons of straw is equivalent to a ton of the best coal. We have no especial arrangement for using the straw. The same furnace and boiler are in service, as when burning any other fuel, only that we have constructed sheet iron chutes to the furnace doors with flaring approaches. By keeping the chutes full of straw and gradually working it into the furnace as consumed, we avoid the necessity of constantly opening and closing the furnace doors. The straw is delivered to us loose and burned in that same condition. It, of course, requires pretty close attention, yet, after all, does not burn away as rapidly as one would suppose. The fiber in the straw makes an intense heat."

THE PENETRATING QUALITIES OF THE ARC LIGHT.

In the first number of the "Photographische Rundschau" for 1896, Herr Schmidt, of Munich, describes some experiments he made about a year ago with regard to the penetrating quality of the arc light. He found that the light from an arc lamp passes more easily through certain substances than sunlight. A wooden board 2 mm. thick was placed before a photographic plate, and an exposure of only 10 sec. to 12 sec. sufficed to attack the plate. India-rubber, bone and ebonite proved less transparent, with a thickness of 2 mm., an exposure of half an hour was required to cause the same effect as through wood. Celluloid was found, however, nearly opaque. A 43-ampere continuous-current arc lamp was employed, the photographic plate being placed about 16 inches from it.

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CONTENTS.

EUROPEAN ELECTRIC RAILWAY STATISTICS.

THE marvellous rapidity with which electric traction was adopted in the United States could not but have its influence on the city passenger traffic of other countries, but it has taken practically ten years to convince Europe that the horse could no longer compete for dividends with the trolley. But now that our friends across the ocean have become convinced of that fact, it would seem as if they were on the road to match our own record in time, as shown by the excellent table of statistics compiled by our contemporary, "L'Industrie Electrique." The accompanying tables,, which show the number and character of the roads now in operation in Europe, indicate very clearly the trend of electric railroading abroad. The trolley, of course, far outnumbers all other systems. Of the others, we may ignore practically those roads with central rail, as they are mostly of short length, where placed on the surface; or they are so situated that they are rendered inaccessible to the publis, such as in the City and South London tunnel, or on the Liverpool elevated railway. But the eight accumulator roads in Europe, representing an increase of four during the year, are more significant. The largest system of this type comprises three roads in Paris, operating 19 storage battery cars, some of which have been doing duty since 1892, and the addition of the third road last May seems to indicate that for the conditions there existing the storage car has proved satisfactory. We would also draw attention to the Hague-Scheveningen road, in Holland, which

Countries.	Length of track, Kilometres.	Power in K.W.	No. of Motor Cars.
Germany	406.4	7,194	857
England	94.3	4,243	143
Austria-Hungary	71.0	1,949	157
Belgium	25.0	1,120	48
Bosnia	5.6	75	6
Spain	29.0	600	26
France	132.0	4,490	225
Holland	3.2	320	14
Ireland	13.0	440	25
Italy	39.7	1,890	84
Sweden and Norway	7.5	225	15
Portugal	2.8	110	3
Roumania	5.5	140	15
Russia	10.0	540	32
Servia	10.0	200	11
Switzerland	47.0	1,559	86
Total	902.0	25,095	1,747

Countries.	Roads with overhead conductors.	Conduit roads.	With central rail.	With accumulator.	Total No. of roads.
Germany	35	1	.	.	36
England	7	1	8	1	17
Austria-Hungary	6	1	.	2	9
Belgium	3	.	.	.	3
Bosnia	1	.	.	.	1
Spain	2	.	.	.	2
France	11	.	1	4	16
Holland	.	.	.	1	1
Ireland	1	.	.	.	1
Italy	7	.	.	.	1
Sweden and Norway	1	.	.	.	1
Portugal	1	.	.	.	1
Roumania	1	.	.	.	1
Russia	2	.	.	.	2
Servia	1	.	.	.	1
Switzerland	12	.	.	.	.
Total	91	3	9	8	111

has been in operation since 1890, and is now operating 14 motor cars and 2 trailers. Considering the popularity of the storage battery for stationary purposes abroad, it is somewhat disappointing to find but three or four roads which have adopted them in the stations as load equalizers, but that this will follow in due course of time we have not the slightest doubt. Conduit roads still seem to lag, but, when their cost is considered, this ought to excite little comment. Indeed, in spite of the slow progress in this direction in the past, even in the United States, we believe that there will be much work of this character done in the near future. The conduit roads in New York, Washington and elsewhere will soon determine the practicability of this type of road, and we have no fear for the final outcome. A glance at the above tables brings out in strong relief the enterprise of Germany in electric railroading, in which her record is well abreast, if not ahead, of that of her electric lighting work. The Germans, indeed, may well be called the Yankees of Europe in electrical matters, and her neighbors on the Continent, as well as across the Channel, ought to profit by her example. Perhaps a glance at our own street railway statistics may act as a further stimulus, and hence we give the record below, which is as nearly correct as it can be obtained, considering the enormous extent of the industry:

Length of track, electric roads..........miles	10,363
Length of track, horse roads............miles	1,914
Length of track, cable roads............miles	632
Length of track, miscellaneous roads.....miles	679
Number of cars, electric	24,745
Number of roads, electric....................	976

In Pittsburgh a cable plant that has cost over $10,000,000 is about to be ripped out to make way for electricity. It is really a pity not to have used the cable trough for a conduit system; but, probably the roadbed had deteriorated too much to allow of such a thing being done. The incident shows, however, the way things are tending in America.

BUSINESS CONDITIONS.

BRADSTREET'S review of trade for the first three months shows that the number of business failures in the United States was greater than ever before in any such period, being 4,512, or 700 more than the dismal first quarter of 1895. The increase lay largely in the Western States and in New York City, and it is attributed to an undue extension of credits because of the assumed prospects of general improvement in business. To us it seems to be due to foolish war alarms and the fear of a dishonest system of currency. But for these conditions, we believe trade would have been much better. Even now, we look for steady, if slight gains, but nothing marked in the way of recovery appears possible until after election. The effect of an average Presidential campaign is perhaps equal in its bearing on business to that of a "small war," and fewer elections would be a decided gain.

There are obviously exceptions to the general drift. While it is satisfactory to know that the recent dullness in electrical industries is only normal as compared with what exists in other branches, it is evident when we look at the activity in the bicycle trade, that in some lines a good business can often be done when prospects on the whole are bad. We look upon the coming National Electrical Exposition as a hopeful and legitimate means of stimulating a slack demand. It will be full of things old and new that the public know little about but ought to buy; and if attention is thus drawn to them the chances of increased sales are infinitely larger than if nothing were attempted. For this reason, the success of the exposition is a common cause to which all should gladly lend their best efforts.

MR. EDISON ON THE X-RAY AS A SOUND PHENOMENON.

MANY have been the hypotheses put forward to account for the action of the Röntgen ray, but the most startling thus far is that which Mr. Edison brings out in his remarkable contribution to our columns in this issue. One is bound to look askance at the proposition that the X-ray is a phenomenon due to sound vibrations whatever be their order of amplitude, but Mr. Edison bases his opinion on some experiments as well as on some of the heretofore unexplained actions of the vacuum tube as a source of the X-rays. While Mr. Edison is well aware of the arguments which may be brought to bear against his "sound" hypothesis, there is no doubt that some observed actions of the X-ray are readily explained on that assumption; and, as a hypothesis, pure and simple, it is certainly worthy of note. With the great inventor's fertility of experiment and the facilities at his command, we may soon expect further facts in support of his views.

We print this week also a number of additional contributions on the subject, three of which are devoted to the source of the X-rays. Opinion still differs on this point. But the accumulated evidence seems to tend strongly to the confirmation of Professor Röntgen's original observation that neither the cathode nor the anode, but the fluorescent spot on the glass is the source of the X-ray. The very beautiful pin-hole experiments of Messrs. Scribner and McBerty would appear to add strong weight to the previous evidence on this point, as does also the novel method employed by Professor Stine. An interesting line of investigation has also been taken up by Mr. E. P. Thompson in order to determine whether phosphorescence produced by means other than electrical bombardment acts as a source of X-rays. The results thus far have been negative, but it is to be hoped and expected that further work in this direction may be carried on.

WHISKERED MESSENGER BOYS.

THE American District Messenger Company, of this city, is a progressive concern, and some of its plans must meet with instant approval. Such, for example, is the intention to have a bicycle corps which will operate all over the region lying in the uptown section of the city. To be able to summon brisk Ariels of this kind will be a decided boon, and will do much to place the district messenger system again on terms of equality with the telephone, while there will still be the advantage of being able to transport objects of bulk.

But when we turn to the proposition that all messengers must be close shaven, we hesitate. Of course everybody knows that for a long time past the district messenger "boys," like those one employs in the tropics to hold a horse or perform personal service, may be of any age, so that it is no shock to learn that many of them are fathers of families. But why should they be put to the expense and indignity of shaving, if their years are no drawback? It would be better to drop them from the employ, for certainly the possession or lack of whiskers is no criterion of efficiency. We would venture to suggest that very often messengers of a ripe age are preferable, hirsute or otherwise, and that it might be well to organize the older "boys," say from 25 up to 150 years old, into a commissionaire corps, after the useful English fashion.

TELEPHONY AND TELEGRAPHY.

ANNUAL REPORT OF THE AMERICAN BELL TELEPHONE COMPANY.

THE annual meeting of the American Bell Telephone Co. was held last week. The annual exhibit for year ending Dec. 31 compares as follows:

	1895.	1894.	1893.	1892.
Gross	$ 5,124,952	$4,848,244	$5,781,076	$5,100,886
Expenses	1,911,193	1,724,459	1,855,591	1,689,211
Net	3,213,759	3,123,785	3,925,485	3,411,674
Regular divs.	2,502,453	2,400,000	2,214,156	1,927,227
Extra divs.	630,000	600,000	1,125,000	991,863
Total surplus	2,151,011	2,151,011	2,151,011	2,151,011

The directors recommended that stockholders vote an increase of 10 per cent. in the share capital. The ticket makes no change in the directory.

The last year has been one of unprecedented growth in the output of instruments, in the number of exchange subscribers, and in the mileage of wire, whether used for exchange purposes or for toll lines. The number of telephones outstanding on the 20th day of December, 1895, exceeded the number outstanding on Dec. 20, 1894, by 92,470, much more than twice the gain in any previous year, and about three times the average yearly gain.

This stood, too, for an increase in the number of subscribers of 38,263 on Jan. 1, 1896, as compared with the year previous. But not only has the business increased with such great strides during the year, but the tendency to turn itself into the best class of service, metallic circuit, has continued without abatement, or rather has increased rapidly. Jan. 1, 1896, finds the total number of metallic stations 94,747, being a gain during the year of 40,067 over the number with which the year began. A comparison with the figures of the first of the last four years may be interesting. They are as follows:

These figures show increase from year to year: Jan. 1, 1892, showed 11,584; Jan. 1, 1893, 23,053; Jan. 1, 1894, 37,648; Jan. 1, 1895, 54,680; Jan. 1, 1896, 94,747.

In connection with this fact should be noted the increase of 33 per cent. in the number of toll line conversations, the metallic circuit subscribers being large users of that class of service.

In the Long-Distance Company's system there were on Jan. 1, 1896, in operation 5,804 miles of pole line and cables and 90,251 miles of wire, connecting 149 offices, an increase during the year of 1,187 miles of pole line and cables, 14,695 miles of wire, and 14 offices.

The introduction, in many of the larger cities, of the measured service system, to which reference was made in preceding reports, has been productive of good results in bringing the service within the reach of many who, not having occasion for large use of the exchange connection, did not feel justified in paying the rates which would entitle them to unlimited service.

During the year the companies leasing instruments expended for new construction $6,463,000; for addition to real estate, $465,000, and for repair and reconstruction, $7,223,000, making a total of $14,151,000 applied to extension and care of the telephone plant in the United States.

Expenditure upon this scale has now been going on for many successive years, and has resulted, not alone in the building up of a very extended telephone system, but in bringing that system, throughout the country as a whole, to a high state of efficiency.

The principal cities and towns through most of the States east of the Mississippi are now connected by wire, and conversation can be held by telephone over distances of 1,500 miles, which is more than twice the length of line anywhere brought into use for this purpose outside the United States.

The stockholders re-elected the directors and voted to increase the capital stock from $21,500,000 to $23,650,000.

Chairman pro tem. W. H. Forbes said: "The sale of 21,500 shares at $200 a share would yield about $4,300,000, and the necessities of the company during the coming year will just about absorb that amount of capital, so far as we can see."

The total wire mileage at the end of 1895 was 459,728, an increase of 63,054 in twelve months. The number of stations was 281,695, an increase of 38,263. The estimated number of exchange connections daily in the United States, made up from actual count in most of the exchanges, is 2,351,420, or a total per year of about 757,000,000. The number of daily calls per station varies in different exchanges from 1 to 16 3-10, the average throughout the United States being 8⅓, which shows a slight decrease from last year in the average use made of the telephone, by each subscriber, due to the introduction of the measured service system. The average cost to the subscriber varies, according to the size of the exchange and character of the service, from less than 1 to 10 2-10 cents per connection. The extra territorial and wire mileage at the end of 1895 was 215,687 miles, an increase of 35,130.

ELECTRIC TRANSPORTATION.

CAN ELECTRICITY SUPPLANT THE STEAM LOCOMOTIVE ON TRUNK RAILWAYS?—VII.

BY

Wm. Baxter, Jr.

AS stated above, the weight of motors is about 2,200 pounds; but, if mounted on the axle, the armature shaft, the gears and casing would not be required, and this would reduce the weight by about 400 pounds, which would bring the weight of motors proper down to about 1,800 pounds each, or 3,600 pounds for the car equipment. This work, it must be borne in mind, is performed with armatures 18 inches in diameter, and, therefore, is much below what can be accomplished with machines of much larger capacity, in which the diameter of armature would more nearly approach to the diameter of the wheels. But even the above figures, which are far below what can be done on a large scale, show that a horizontal effort can be obtained equal to more than 22 per cent. of the weight of motors, and this is on the assumption that the motors are mounted on the axles. The actual performance of the machines above referred to (as they are built, that is, single reduction machines) shows a horizontal effort equal to about 70 per cent. of their total weight.

The energy output, when reduced to motor on the axle basis, would be about 23 horse-power, which is at the rate of 156 pounds per horse-power; but this also represents a speed of about 12 miles per hour. The same weight at 48 miles per hour would give four times the output, or 1 horse-power to 39 pounds.

These figures, which are taken from actual results of machines in every-day use, show conclusively that it is possible to mount motors on the axles of trucks having 42 to 48 inch wheels that will exert a horizontal effort equal to 40 or 50 per cent. of their entire weight and give an output at 50 miles per hour of 1 horse-power for 20 pounds of weight, or even less. It will thus be seen that the assumption that motors can be built that will do four times as much work as locomotives of the same weight is well within the limits of possibility, for only about 50 per cent. of the weight of engine and tender rests on the driving wheels, and, therefore, unless the traction co-efficient is taken as high as 25 per cent., the locomotive wheels would slip with a load behind them that the electric motors would draw without trouble.

In the foregoing paragraphs the capacity of locomotives has been assumed to be proportional to the weight on the driving wheels. This, in fact, is the true measure of their capacity at slow speeds; but, when the velocity increases beyond a certain point, other factors enter into the calculation, and then the weight no longer stands at the limit of the capacity. Somewhere above the speed at which weight on drivers ceases to be a measure of capacity the horizontal effort becomes less and less as the speed increased; not only that, but the portion available to draw the train also becomes a smaller percentage of the whole. These conditions also hold good for electric motors, but to nothing like the same extent. This will appear more clearly after the following explanation:

At slow speeds the only resistance to the motion of a train is the friction of the axles and the rolling friction of the wheels on the track, that is, assuming the track to be level. As the speed increases the atmospheric resistance begins to make itself felt. From that point onward the horizontal effort is expended partly in overcoming head or atmospheric resistance and partly in train resistance. The higher the speed the greater the head resistance.

Now, if a locomotive could, at all velocities, maintain a constant torque, then the load it could draw at any speed would be equal to the horizontal effort due to the torque, less the head resistance. But the locomotive cannot maintain a constant torque, because, as the speed increases, a point is soon reached where the boiler is no longer able to keep up the supply of steam required to maintain the maximum pressure in the cylinders. As the speed increases, the supply falls still shorter. As a result, from that speed at which the capacity of the boiler begins to be taxed, the torque begins to drop. We, therefore, find that when a point is reached where the head resistance begins to balance a large proportion of the horizontal effort, the useful capacity of the locomotive, or its ability to draw cars behind it, rapidly decreases. As soon as a speed is reached when the boiler fails to keep up the

necessary supply of steam, the decrease in effectiveness becomes still greater, because we then have a constantly reducing horizontal effort, as the speed increases, and a constantly increasing proportion of this effort required to overcome head resistance. Now, it is quite evident that under these conditions a speed is soon reached where the entire capacity of the locomotive is required to overcome the atmospheric resistance, and then the efficiency of the machine becomes zero.

These conditions do not obtain to the same extent with electric motors. The resistance of the atmosphere, it is true, has to be overcome in either case, but the horizontal effort of the electric motor can be kept at its maximum at any desired velocity; therefore, we have the case of a constant quantity being reduced by a gradually increasing quantity, against a decreasing quantity being reduced by an increasing quantity. In the case of the electric motor we reduce the effective capacity by whittling down at one end, but with the locomotive we reduce the effective capacity by whittling down at both ends.

The locomotive carries the source of energy on its back, so to speak, and, therefore, its capacity is limited, but the electric motor derives its energy from the power station, which is a practically unlimited source. Every electrical engineer knows that if a motor will give a certain torque at one speed it can be made to give the same torque at any other speed by simply changing the winding to suit the desired velocity. If two motors are mounted on each truck of the motor car, they can be so connected as to be operated four in series, two in series and two in parallel, or four in parallel. With such an arrangement, the maximum working torque could be obtained at 20, 40 or 80 miles per hour, or at 15, 30 and 60, or 25, 50 and 100, or at any other set of velocities having the ratio of 1, 2 and 4 approximately.

The above statement holds good for any speed, because the torque in a constant field is proportional to the ampere turns on the armature, while the electromotive force is proportional to the number of turns of wire. Now, if we place half the number of turns of wire on both the field and armature and double the current, the magnetic flux through the field will be the same and the ampere-turns on armature will be the same; therefore, the torque will be the same; but the number of turns of wire on the armature will be one-half, and, therefore, the electromotive force will be one-half, and under the same difference of potential between terminals the speed would be doubled.

The saving in energy required to move a train by reason of the saving in weight of motors would not be very great for freight service, owing to the fact that the weight of the locomotive and tender does not constitute a very large proportion of the whole, as will be seen by reference to the following brief calculation of the power required for such service.

Estimate of Power Required to Draw an Axerage Freight Train on the Pennsylvania Railroad, and Coal Consumed Per Mile:

Average number of cars per train (See Table 7)	30
Average weight of car, pounds	22,000
Total weight of cars, 30 x 22,000	330 tons.
Average weight of freight per train (see Table 7)	317 tons.
Weight of locomotive	75 tons.
Total weight of train	722 tons.

Average speed (see Table 7) 15 miles per hour, or 1,320 feet per minute. Traction resistance, 8 pounds per ton; horsepower to draw train is:

$$\frac{722 \times 8 \times 1320}{33{,}000} = 231 \text{ h. p.}$$

This is the power required on a level track. Making an allowance of 25 per cent. to cover extra effort going around curves and up grades, we will have, say, 290 horse-power, and this at a coal consumption of 6 pounds per hour would equal 116 pounds per train mile, and the total amount of coal consumed by all the freight locomotives on the road for one year would be:

$$\frac{20{,}400{,}355 \text{ (train miles)} \times 116 \text{ (lbs. per mile)}}{2{,}000} = 1{,}183{,}220 \text{ tons.}$$

This calculation has been carried out to the point where it shows the total amount of coal required to haul all the freight trains on the Pennsylvania Railroad for one year, so that the figures so obtained may be used later on in making an estimate of the relative cost of doing the work of this road by electricity as compared with steam. For the present, however, we are only concerned in showing the relation between weight of train and motive power in the two systems and relative cost of power for work performed. We will, therefore, only use here such of the above figures as may be required for that purpose.

The total weight of train, as given in above estimate, is 722 tons, and the weight of locomotive and tender is 75 tons, or about 10.4 per cent. of the entire weight. Now, if we should replace the locomotive by a motor car (which could be a large caboose car), the only additional weight would be that of the motors, which, as has been shown, would be less than 25 per cent. of the combined weight of locomotive and tender, or, in round numbers, 19 tons. The total weight of train would then be reduced to 666 tons, and the weight of motors would amount to about 2.85 per cent. of the total weight, instead of 10.4 per cent., as is the case with steam. The weight of the same train, when drawn by motors, would then be about 92.2 per cent. of the weight when drawn by a locomotive. The saving in power would, therefore, be nearly 8 per cent., and this is in freight service, where the weight of engine only constitutes about 10½ per cent. of the total. In passenger trains the reduction in weight would be very much greater, as the following will show.

THIRD ANNUAL MEETING OF THE TEXAS STREET RAILWAY ASSOCIATION.

THE third annual meeting of the Texas Street Railway Association convened at Galveston on March 18, 1896, with the President, W. H. Sinclair, in the chair. After an opening speech by the President, the convention got down to business and began discussion of various subjects, as follows:

FARES.—Whether the use of tickets of any sort should be advised; if a reduced ticket, in what form and how handled and sold. Only one railway represented sold reduced fares and none sold children's tickets. The Dallas roads require full fare for all children, except babes in arms; others, all children occupying seats.

EMPLOYEES.—The question of whether time was wasted and accidents added to by not using conductors. Cost of a conductor is $547.50 per year; the general length of time of employment is 12 hours—an average pay of $1.55 per day. Some pay by the hour, some by the day and some by the month. It was generally conceded to be a good plan to increase the pay after certain length of service. One road works its men four days and they are off one; another two days, and off one, except for relieving times. Other roads use three men to two cars, one man being a swing-run man.

Considerable discussion was had as to what are repairs and what are properly expenses. Mr. Hayward, of Houston, submitted a blank specification, which was generally approved.

POWER.—Only three roads could give definite figures on the cost of power per mile; they were, .0177, .0144 and .014, the latter under hired power. One road other than these, although not giving definite figures, must have a lower rate, because they have water power, and pay very little for it.

Considerable discussion was had as to the amount of training a man ought to have in order to save power, and the kind of training.

On the second day's session, March 19, the representation was as follows: Dallas City Railway Company, Houston City Street Railway Company, Galveston City Railroad Company, Fort Worth Street Railway Company, Laredo Electric & Railway Company, Austin Dam. & Suburban Railway Company, Austin Rapid Transit Railway Company, Queen City Railway Company, of Dallas.

The president presented extracts from the Connecticut and Massachusetts Railway Commissioners' reports, which in general show: That there has been a slight increase in the income for the year ending Sept. 30, 1895, and considerable decrease in cost of operation; but that the cost is still, in the lowest case, 68.93 per cent.; in the highest, 76.13 per cent. Of the 85 roads in the list, which includes St. Louis, only 46 have paid dividends.

ELECTROLYSIS.—Several instances were given of supposed destruction by electrolytic action; in few of the cases could this be definitely traced, nor was there any united opinion as to plans of overcoming the trouble. It was the general opinion that heavier bond wire was necessary. Messrs. Hayward, Urie, Hendricks and Wakefield all gave instances of trouble. In one case a six-inch condensing pipe had been perforated, but was afterwards encased in the tunnel, and so far with good results. In another case water pipes had been badly damaged, but no main pipes. In another, service pipes only had been damaged, and the water superintendent advised connecting to the water pipes direct. In another city the water superintendent refused to allow such connections. In one city the electrician had recommended that they encase the service pipes in vitrified clay sewer pipes. Some discussion was had upon the plastic bond; only one member seemed

to have much knowledge of it—Mr. Young, of Galveston. He advised its use, and maintained that it was not affected by the up-and-down movement of the rails that it joins.

REPAIRS OF TRACK.—Messrs. Hayward, Drake and Hendricks advocated the heaviest rail possible. Mr. Wakefield said: "Will the investment not reach a point where it ceases to be economical?" Mr. Hayward said: "The difference in cost, at the present price of rail, between 35 lb. and 75 lb., would be $1,700 per mile only; add to that about 10 per cent. more for labor and handling." Mr. Drake said: "The labor and the mere handling of the rail is a small percentage of the total expenditure for labor."

Opinion was general that the T-rail was proper, except where paving blocks were used; and the opinion of the majority was even then that the T-rail could be so blocked as to prevent trouble.

The President—"I think the city authorities in general are rapidly coming to the opinion that the T-rail has not the objections that have been formerly urged against it."

Mr. Hayward cited a case where the T-rail was specified for macadamized streets. "It costs from ten to fifteen per cent. less than girder, especially when you consider the difference in the cost of fittings, connections, etc."

Mr. Sinclair—"The salt air in Galveston corrodes our rails rapidly, no matter what the weight; but we find that the labor of keeping up the joints of light rail is enormous."

Mr. Drake—"We find that the difference between the 25 lb. and the 60 lb. rail is more than saved in truck and car body repair account."

Mr. Hendricks suggested that a quicker stop could be made on heavy rails than on light; he advised ties close together.

OVERHEAD WIRES.—A T-wire reversed was talked of and a cut shown. Mr. Hendricks said: "I saw this in the midst of a sleet storm, and it did not seem to be affected by the extra weight more than other wires, and because of the fastening, arcing and consequent pitting of the trolley wire will be prevented at the cars."

Mr. Young—"Regarding the bi-metallic wire, it is guaranteed to have a tensile strength of 5,164 pounds; size 00; weight 60 pounds less than copper; has steel core; cost about half that of copper." The general opinion was, however, that a No. 0 hard drawn copper was standard.

MOTORS.—As to the life: Experience of Messrs. Hendricks and Wakefield, armature life, two years. Mr. Sinclair, of Galveston, one year.

Mr. Drake—"Our armature man showed me where armatures had become crystallized, probably by heat or overload." General opinion was that overload was the principal cause of the destruction of armatures.

POWER.—The price of coal was found to be $3.65, $2.50 and $4.10 in front of boilers. The mileage of cars per day was from 100 to 180. Nut and slack coal mixed was used, excepting in one case, where Arkansas was used.

CAR BODIES.—One member had built new and repaired several car bodies; does not advise building new ones locally.

INSURANCE.—Discussion under this head covered a wide range. Briefly, the insurance companies were charging from 2 per cent. to 3½ per cent. on frame power house buildings and cars on track and in shed attached; from that on down, according to the building, until in detached car house, the price is 1¼ per cent.

Mr. Drake suggested the organization of the Texas Street Railway Mutual Insurance Company, and that ten per cent. of the gross earnings of each line, together with the regular insurance charges, according to board rates, be paid into the treasury annually; that a certain percentage be kept in reserve. With the rest of the money employed, after $100,000 was paid in the treasury, a corporation could be regularly organized. Until that all payments would have to be upon honor. A permanent committee upon insurance was appointed as follows: Carl F. Drake, of Austin, chairman; H. C. Chase, of Houston City Railway Company; J. L. Sale, of Dallas.

CAR WHEELS.—Various makes and styles of car wheels were discussed pro and con., and there seemed to be no unanimity of opinion. It was conceded that the cost of the wheels was not the principal item, but the cost of taking them off and putting them on, and the taking of the cars out of service. It was therefore argued that the best wheel possible should be obtained. It was found that the soft cast shoe was generally used and recommended, though some had the cast and wrought mixed.

TIES.—Cost of ties was found to run from 25 to 55 cents, delivered; cypress, longleaf pine and oak. The cypress for damp soil was found to have long life, but the other should be treated. In treating ties Mr. Drake suggested that the ends should not be covered or painted, as that would prevent the sap from running out in the process of curing, and fermentation and internal decay would result. A white oak tie was thought about the best.

LITIGATION AND ACCIDENTS.—The cost ran from $500 to $2,500 per annum, exclusive of attorneys' fees, which average about $1,200. It is the general opinion that about 75 per cent. of the amount of damages paid was wrong and that the judgments were due to the general feeling against corporations and false swearing.

METHODS OF INCREASING REVENUE.—Discussion under this head covered a very wide range. One instance was given where an $80,000 park had brought in $30,000 per annum increased revenue at a small additional expense. Another instance was given where a negro park cost about $3,500, and paid for itself many times during the season.

Mr. Hayward—"I find it is absolutely necessary to study the people closely before presenting them an attraction."

Under general discussion—It is found that where a band had been successful in one place, in another it was an absolute failure, no matter how good the music. It is found that people will not pay a fare and then pay admission to any appreciable extent.

Mr. Drake—"We tried to give good entertainments and charge a small admission, but found it was not patronized; we then gave very ordinary entertainments free, and had to turn people away." Mr. Drake believes in an amusement circuit. Mr. Hendricks found that a negro park paid, and that band concerts took very well.

Mr. Wakefield—"We find that in Dallas the factory man is the one who patronizes the cheaper entertainments, and we have not enough of this class to make it pay. Wealthier people want attractions that cost more than the increase in business warrants."

Mr. Urie—"We find it profitable to keep in with the baseball people; they are well patronized at Galveston.

On the question of appointing a committee on summer attractions, no action was taken.

The Insurance Committee was made permanent, and the President and Secretary were added to it in an advisory capacity. W. H. Sinclair, of Galveston, was elected President, and Carl F. Drake, of Austin, Vice-President; C. L. Wakefield, of Dallas, Secretary and Treasurer. These, with A. H. Hayward, of Houston, and George B. Hendricks, of Fort Worth, form a directory of five.

The next meeting will be held at Austin on the third Wednesday in March, 1897.

COMPLETION OF THE PITTSBURG TROLLEY CONSOLIDATION.

The various Pittsburg traction lines embraced in the new deal, backed by Philadelphia capital, went into the formal possession of the new owners on April 2. The lines are the Pittsburg, the Citizens' and the Central Traction companies, the Duquesne Electric system, the Pittsburg, Allegheny and Manchester Railroad and the Allegheny Traction Company.

The terms of the consolidation have been hashed and rehashed. The capital stock of the consolidated company will be increased and there are promises of great improvements in the service. The Fort Pitt line, it is expected, will commence running cars out Liberty avenue by April 20. The cables on the Citizens' and Fifth Avenue lines are to be replaced with trolleys and later on the cable on the Central will be abandoned. A new power house is to be built on the Allegheny River front, between Forty-second and Forty-third streets, and it will furnish power for all the lines on the system. All-night cars running through to Wilkinsburg every fifteen minutes are promised on the Fifth Avenue line, and at longer intervals on other roads.

The transformation of the three cable roads into trolley systems is to cost $4,000,000, and work will be begun as soon as the new Fort Pitt road is in operation. It is proposed to build several long suburban extensions of the present lines in a few years. The cable plants and tracks that are to be eliminated cost $12,000,000 for construction.

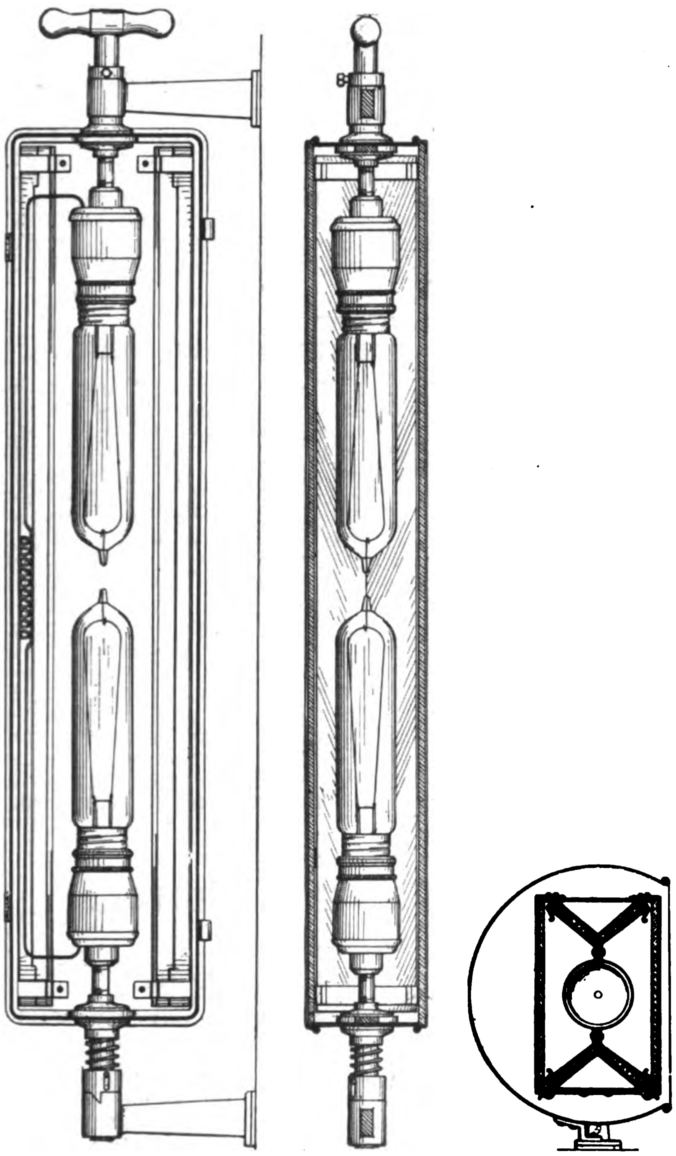
FIRST ELECTRIC LOCOMOTIVE FOR CANADA.

A dispatch from Montreal of March 26 says: The Canadian Pacific branch has been leased for thirty-five years to the Hull Electric Company, which will convert the road, which is nine miles long and connects Hull and Aylmer and the Pontiac and Pacific Junction Railroad, into an electric road. An electric engine, the first to be used in Canada, will be put on. The company also lights Hull and Aylmer by electricity.

MR. KEELY, of motor "fame," now has a vibratory dynamo, and his stockholders want him to get a patent on it as soon as possible. Then more money can be raised. Let the patent be secured by all means, if possible.

ENGLE ILLUMINATED ROUTE INDICATOR.

In many of our large cities it is customary for street car companies to paint all their cars of one color, as, for example, in Philadelphia, where the only distinguishing mark to indicate the different lines is a small wooden sign-board at the front and rear of the car, suspended above the dashboard, upon which is inscribed in black letters, often upon a yellow ground, the destination of the car. While this, even in daylight, is hard to decipher even at a short distance, it is almost, if not entirely, invisible at night, causing a great deal of annoyance and vexation to the traveling public, who not infrequently, through their inability to read the sign, get on the wrong car, very rarely discovering their mistake until a fare has been exacted.



ENGLE ILLUMINATED SIGN ON STREET CARS.

FIGS. 1, 2 AND 3.

To remove this vexation Mr. Robert H. Engle, of Philadelphia, has devised and recently patented an ingenious revolving, transparent, electrically illuminated sign. Fig. 1 represents a longitudinal interior side view of the sign and contents, the casing of which is made of sheet metal. Fig. 2 is a sectional plan view of the same, looking down from the top, showing lamps and reversely inclined reflectors. Fig. 3 represents a transverse section through the middle of the sign, showing the reflectors transversely inclined, and the upper and lower reflectors reversely inclined. These reflectors are set at an angle of inclination to obtain the maximum reflection.

As will be seen by reference to Fig. 3 the sign is inclosed by a semi-circular shield, for the purpose of obscuring the inner sign plate, so that only one—that is, the outward sign plate—is visible at a time. The casing of the sign is trunnioned on each end, and adapted to rotate in suspended hangers, which are usually mounted on the under side of the car hood, above the dasher. One trunnion is provided with a handle of insulating material, for rotating the sign, the hangers themselves serving as conductors to carry the current to the lamps, the lamps being connected in series or multiple according to voltage or the plan of the wiring of the car. On the opposite trunnion is a spring-actuated stop collar or clutch, on the ratchet principle, which limits the rotation of the sign, usually to a half turn, and secures it in proper position against any possible displacement by the jarring of the car, or otherwise.

One of the important features of this form of illuminated sign is that a maximum illumination is obtained by a minimum expenditure of current, by reason of the position and efficiency of the reflectors, together with the cylindrical form of lamp, it being possible to use a casing having one or many sign plates, and the diffusion of the light being so perfect there is no part of the sign plate better illuminated than the other, in fact, a more even distribution could not be obtained except at the expense of a great number of lamps, and a corresponding increase of power consumed.

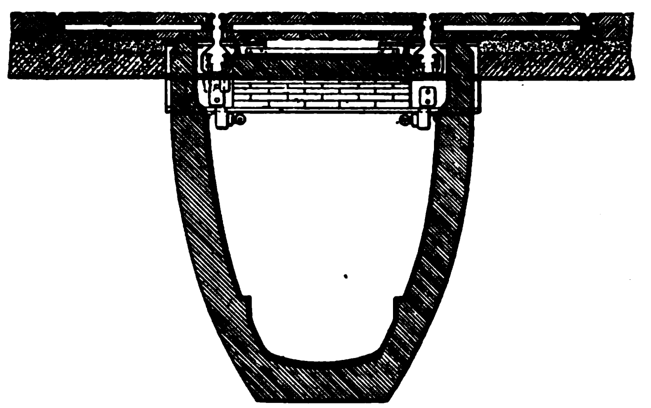
Aside from its uses as a route indicator for street cars, its adaptations render it admirable for advertising purposes, either as a fixed or rotatable sign, in any position where current is obtainable.

THE PROPOSED ELECTRIC RAILWAY CONDUIT IN PARIS.

In a paper recently read before the Société des Ingénieurs Civils, of Paris, on the subject of "Electric Railways with Underground Conductors," M. A. Lavezzari describes an interesting conduit-railway which is projected in Paris. The line will begin at the Place Cadet, near the Porte de Montmartre, and will extend through Rues Cadet, Rochechouart and others, to the end of Rue du Poteau. The road will be 1⅝ miles long, 1⅛ miles of which will be double-tracked, and the remainder single-tracked.

The heaviest grade is only 6 per cent., and occurs in Rue Rochechouart; the other grades average less than 3 per cent. The smallest curve radius is 105 feet. The localities traversed are of the most thickly populated in Paris, and those where travel is most active throughout the day, and it is expected that the line will transport 20,000 passengers a day.

The gauge of the track is one metre (39⅜ inches), and on the double-track portion of the line the conduits are arranged as shown. One rail of each track is of the usual girder type, but the other is a modified T-rail, and a similar rail is laid alongside it, with sufficient space between for the passage of the plow. The conductor conduit is located, of course, immediately beneath these rails, and contains both the positive and negative conductors, the rails not being included in the circuit.



PROPOSED DOUBLE-TRACK CONDUIT ROAD, PARIS.

The beams rest by means of cast feet on the two side walls of masonry of the main conduit, which is really a large sewer of the usual Parisian type, 5 feet 7 inches high under the arch, and provides ready access for the inspection and repair of the conducting system. To facilitate inspection and the transportation of material small trucks may be run along the lower part of the conduit; the track will be formed by two angle-irons set in the masonry.

The transmission of energy between the station and the cars is provided for by two feeders, positive and negative, which are supported in the upper part of the large conduit. These

feeders, for perfect separation, are held apart every thirteen feet by supporting insulators. Every 328 feet connection is made by branch conductors between the feeders and the working conductors, which latter are of steel and channel shaped. The branch connections are single conductor flexible cables, provided at one end with pins or shanks which fit in sockets attached to the feeders, permitting ready disconnection when it is desirable to cut out a section of the line.

The steel working conductors are supported every 6½ feet by cast arms bolted to the short beams forming the yokes. Double-petticoat porcelain insulators are provided for the conductors. Every 1,000 feet bells or telephone instruments will be installed in the large conduit to place each section of the line in communication with the power station. The collector has the form of a shuttle and rubs against the faces of the steel conductors, contact being maintained by means of springs. The shuttle is flexibly attached to a plow suspended from the car; both are so arranged that in case the car leaves the track they will detach themselves and become disconnected mechanically and electrically from the car without causing damage.

The station will contain three engines of 150 horse-power each, coupled by belts or ropes to three 500-volt dynamos, each of 100 kilowatts capacity. The cars will have a capacity, including the platform, of 36 passengers; there will be no top seats. All the cars will be equipped with two motors of 10 horse-power each, but will run in pairs, and the front car will contain all the controlling apparatus, the rear car being provided with motors only.

THE MOTOCYCLE RACE.

In "The Electrical Engineer" of Feb. 5, mention was made of the $3,000 offered to horseless carriages by the "Cosmopolitan Magazine" to be awarded after a race on May 30 over a course of about fifty-two miles, from City Hall Park, New York, to a point near the Cosmopolitan building, Irvington-on-the-Hudson, N. Y., and return to starting point. It has been found necessary to change slightly the percentages on which the award will be made, and, the maximum remaining 100, the divisions are now as follows: Speed, 35; simplicity of construction and durability, 30; ease in operating and safety, 25; cost, 10.

The committee of judges who have consented to act at this test are: Gen. Nelson A. Miles, U. S. A.; William P. Craighill, Chief of Engineers, U. S. A.; H. Walter Webb, vice-president N. Y. C. and H. R. Railroad, and John Jacob Astor.

Entries for the race should be sent early to the "Cosmopolitan Magazine," Irvington-on-the-Hudson, N. Y.

NEWS AND NOTES.

A SYSTEMATIC ARRANGEMENT OF THE ELEMENTS

In the "Zeitschrift für Anorganische Chemie" there is a paper by Julius Thomsen which is of some interest to those of our readers who are watching the steady, though gradual, approximation and identification of chemical and electrical truths. The author arranges the elements in ascending order of the atomic weights in three main groups, of which the first contains two series of seven elements, the second two series of 17 elements, and the third 31 elements. Hydrogen stands by itself. Electro-positive elements are at one end of each of the four smaller series, and electro-neative elements at the other. The new arrangement, amongst other things, serves to show relationships between the elements beyond those shown by the ordinary periodic scheme. The original paper may be consulted in the Zeit. Anorg. Chem., ix., pp. 190-193.

BRITISH EMPIRE EXPOSITION.

An exposition of the above name and character is to be held at Montreal from May 24 to Oct. 12, 1896. Three special prizes of $500 each are offered. One is for the most useful all-round invention connected with electricity and exhibited for the first time at this exposition. Mr. T. T. Stokes, the Commissioner General for New England, 88 Boylston street, Boston, can give information.

CONTEMPORARY ELECTRICAL SCIENCE.

In the "Physical Review" there is an advance paper by W. D. Bancroft upon the chemical potential of metals, vulgo, electromotive forces of cells. He finds that the potential does not depend upon the concentration of the solution, or upon the positive ion of the electrolyte. It may be described as a function of three things—the metal, the negative ion of the salt, and the solvent medium (usually water). Mercury and platinum acquire potentials of an opposite sign to those acquired by other metals with the same negative ion. A very handy water battery is described in the same periodical by Austin and Thwing. Strips of copper and zinc are bent into a peculiar shape round a set of fixed pegs. A copper-zinc couple run downwards side by side, then bend away from each other, and then down again. This makes a kind of shoulder, and the lower ends can be immersed by springing a homoeopathic vial on to the elastic couple and dipping the whole in water. A large number of such cells are placed side by side; the upper parts of the strips are bent again and soldered together, the junctions being mounted in a board and insulated with wax. One board can carry several hundred cells, and they may be filled by dipping the whole into a trough of water. There is a paper on Sahulka's effect in the "Wiener Berichte," 104, by F. Gold. The effect consists in a continuous current observed in an arc between iron and carbon poles fed with an alternating current. It flows from iron to carbon, and may be demonstrated by a magnetic needle. The arc has evidently less resistance in the iron-carbon direction than in the contrary. With a steady continuous current the arc is longer if the current flows from carbon to iron than if it flows from iron to carbon. —London "Electrician."

"FICKER" PHOTOMETRY OF COLORED LIGHTS.

In a recent number of the "Physical Review" an article by Mr. F. P. Whitman gives some account of the use of the "flicker" photometer in comparing lights of different color, and stating that this method approximates in convenience and accuracy to any of the ordinary photometric appliances using lights of the same color. The chief test by which this conclusion is arrived at is that different observers whose vision is normal obtain similar results; whereas, by other methods, the comparison of colored lights by different observers was found to give results often differing by 50 per cent. The flicker method of photometry is based upon researches made by Professor Rood, who has shown that if a rotating disc, rotating rather slowly, is painted with two different shades, either of gray or some other color, a flicker is produced, which, however, will gradually disappear if successive pairs of colors more and more alike are chosen. The author has adapted this principle to a photometer, which he calls a flicker photometer, in which a rotating sector disc is made to give intermittent comparisons between two colored lights on a photometer bar. It is found that differences in color do not, with such an instrument, affect the measurements.

LETTERS TO THE EDITOR.

WHAT WAS GILBERT'S MEANING?

Some questions having arisen as to the meaning of one of Gilbert's statements, I should like to point out that Gilbert's words are: "Electrica, quae attrahunt eadem ratione ut electrum." These may mean that electrics are those things which attract "for the same reason" as the amber, or "in the same manner" as the amber. Most translators have preferred the first rendering. I did so myself until further study revealed Gilbert's actual position with respect to the scientific thought of his age.

Those who prefer to regard Gilbert as an Aristotelian closing the epoch of Greek philosophy, may logically insist on the words, "for the same reason," being the proper translation, since the comparison then rests on a similarity of hypotheses. Others who, like myself, after prolonged consideration, become forced to the conclusion that Gilbert is the great forerunner of the inductive philosophy, will deem "in the same manner" a rendering in better harmony with his work, since the comparison then rests on observed fact.

PARK BENJAMIN.

New York, April 2, 1896.

THE COLLINS SMOKE PREVENTION TESTS.

Mr. B. R. T. Collins' article on comparative tests of smoke preventing furnaces is one which I think all practical engineers will appreciate. In looking over Tables 1 and 2 for economic evaporation and maximum capacity, it appears to me that the temperature of feed water in both tests is extremely low, the highest average temperature being only 100.4 degrees

F. Undoubtedly there is some reason for this. It also seems to me that the consumption of coal per horse-power hour is excessively high, even taking into consideration the low temperature of feed and the low grade of fuel. I am sure there are others like myself who would be pleased to hear from Mr. Collins on the above. C. DOUTRE, E. E.
Richelieu & Ontario Navigation Co.,
Agency, Montreal, March 14, 1896.

SOCIETY AND CLUB NOTES.

DR. EMERY ON ELECTRICITY IN RELATION TO STEAM AND WATER POWER.

DR. CHARLES E. EMERY, of New York, in his lecture at the Franklin Institute, on "The Relations of Electricity to Steam and Water Power," said that at present electricity acted simply as a convenient means of transmission, making it possible to utilize water power in mountain fastnesses and at considerable distance from centers of trade and mechanical operations and transmit it where the energy can be utilized. It would be possible through a pair of conductors ⅛ of an inch in diameter to transmit sixty horse-power 133 miles if the electrical pressure could be practically maintained at 20,000 volts. This voltage has been employed experimentally, but practical transmissions are made at 10,000 volts.

"It is now considered advisable," said Dr. Emery, "to employ all the power of a water power development to generate electricity and use electric transmission in the place of mechanical, not only to the manufacturing establishments in the vicinity, but those at a distance." The lecturer said that for a development of 80,000 to 100,000 horse-power the company could afford to sell power on the different premises in the vicinity for $12 per year net maximum horse-power, and in general could readily obtain $15 to $18 per horse-power. He considered that power could be profitably sold from such development at a distance of twenty miles for $18 to $20 per horse-power in large units, but that the cost of distributing the power to small consumers about the city would be so great as to leave little advantage to them, compared with the cost of steam power.

Dr. Emery believes that large water power may be developed and transmitted locally with advantage, in competition with steam power, even where fuel is cheap; that transmissions to a distance of twenty miles are warranted if power is sold for twenty-four hours or in large units, and stated that where fuel is $3 per ton or over, electric transmission is very generally applicable.

With regard to the above abstract, taken from one of the Philadelphia papers, Dr. Emery writes us: The abstract of my Franklin Institute lecture is correct as far as it goes, but for reproduction in an electrical journal some of the omissions would have an important bearing. It is true that on account of the low price of electric apparatus, the field of electric transmission has been greatly enlarged, and when the cost of apparatus is considered with the probable cost of developing a water power on a very large scale, transmitted power should be sold as low as stated. This does not mean that companies now established can do this, and if not they will have great difficulty in competing with steam power where coal is cheap. My figures on the cost of steam power have been often confirmed, but it is gratifying to find the evidence of Mr. Field ("Cassier's Magazine," March, 1896) that variable steam power for electric plants is actually being obtained at about 1 cent per horse-power hour, as I claimed in my Institute paper at the Niagara Falls meeting. It is only power from water, for which the cost is based on a horse-power year, whereas the cost of steam power depends on the h.-p. hour, most of the expenses decreasing as the power is decreased; so Mr. Foster in reporting the cost of steam power by the h.-p. year ("Electrical Engineer," June 26, 1896), not only deceived himself, but many others. Had he reported on the "horse-power hour" basis for steam, and compared with the cost of water based on the maximum power, as is necessary, he would have found that the charge for transmitted power must, for a variable demand, be less than the cost of steam power on a 10-hour basis, although such power is actually distributed through 24 hours. The transmitted power should readily be offered at such a price, where the high tension transmission can be carried directly to the actual points of utilization. When, however, the cost of a subsidiary system of distribution, with promotion expenses incident to such a work in a city, are added, it does not appear possible for transmitted power to compete with steam power, where coal is less than $3 per ton.

HENRY ELECTRICAL CLUB.

AT a meeting of the Henry Electrical Club, held on March 20, Dr. Louis H. Laudy delivered a lecture on "The Arc Light."

The electric arc, the lecturer said, though used during many years for lighting purposes, was yet imperfectly understood, and the exact nature of the physical changes which took place in it were still very much of a mystery. Many investigators were now at work on the subject, and the lecturer pointed out some of the phenomena which were being studied.

In common with nearly all systems of illumination the arc light depended on the incandescence of carbon. Arcs could readily be formed with many other metals, but the emissive power of carbon, together with its refractory nature and its cheapness, made it the best material for arc lighting.

In describing the conditions necessary to produce the electric arc the lecturer showed that the mere passage of a current between two carbon points had no other effect than to generate heat at the point of contact; but the moment the points were separated the gap between them was bridged by a stream of incandescent carbon vapor. On the position of the carbons and the distance of separation depended the character of the arc, whether flaming, hissing, or silent. Too short a distance produced a hissing arc; increasing the distance made it silent. As the resistance of the vapor between the points increased with the distance, more energy had to be expended to overcome a long than a short arc, and for that reason it was not economical to separate the carbons more than was necessary to avoid the hissing effect. To maintain the distance of separation constant was, therefore, the object most sought in the design of an arc lamp, and it was a problem which had taxed the ingenuity of inventors for many years.

One of the earliest attempts in that was the Jablochkoff candle, in which two carbon rods were mounted side by side, and separated by a partition of some refractory material. While that system of mounting the carbons maintained the distance of separation the same, it required the use of the alternating current, as otherwise one of the carbons burnt away more quickly than the other. The alternating current for arc lighting fell for a time into disfavor, for which reason—with some other objectionable features of the system, among which was the short life of the carbons—the Jablochkoff candle was now only a historical relic. Many other methods of regulating the distance between the carbons had been tried, some of them very ingenious, but few without some shortcoming which led to failure. It was curious to observe how, in this, as in other fields of invention, the same ideas had been tried, abandoned and reinvented.

The most successful system of regulation was that known as the differential, of which the Brush lamp was one of the earliest examples. The differential method of feeding was so called because it employed the opposing forces of two solenoids, one of high resistance, in shunt with the lamp, and the other of low resistance, in series with the arc. The low resistance solenoid acted to pull the carbons apart, while the high resistance solenoid, by neutralizing its effect, permitted gravity to move the upper carbon toward the lower one. As the current each solenoid received depended on the resistance of the arc, a balance was set up which preserved a constant gap between the carbons.

Clockwork, also, had been used to a great extent, particularly in lamps for projection purposes, where it was not only necessary to maintain a constant degree of separation between the carbons, but to keep the position of the arc itself always the same. The lecturer preferred hand regulation for that purpose and exhibited some lamps for projection which were easily and quickly adjusted by hand without the complication of clockwork.

Much of the success of an arc light depended on the quality of the carbons used, and in that respect constant improvements had been made with the result that flickering arcs, once so common, were no longer considered as an unavoidable characteristic of the system.

The electric arc was easily affected by the condition of the air surrounding it, and that had led to the principle of enclosing the arc in an almost air-tight envelope. Many difficulties were met in doing that, but there was no question about its having the advantage of giving a longer life to the carbons. The lecturer described the recent progress of arc lighting in connection with low potential circuits, and stated that the alternating current was gradually being regarded more favorably.

The lecture, which was listened to by a large and attentive audience, was illustrated with many interesting and striking experiments.

PARTIAL PROGRAMME FOR THE N. E. L. A. CONVENTION.

We have received from Secretary G. F. Porter a partial list of the papers and topics that will be presented at the nineteenth N. E. L. A. Convention, to be held in this city May 5, 6 and 7 next. The sessions will be held in one of the large rooms in the Industrial Building, Lexington avenue and Forty-third street. The hotel headquarters will be the Murray Hill Hotel, Park avenue and Forty-first street, within two blocks of the convention hall. Prices to delegates $2 and upwards on the European plan, $4 and upwards on the American plan.

Papers—"Single Phase Self-Starting Synchronous Motors," by F. H. Leonard; "Results Accomplished in Distribution of Light and Power by Alternating Currents," by W. L. R. Emmet; "Acetylene Gas," by L. A. Ferguson, Electrical Engineer of the Chicago Edison Company; "Evolution of the Arc Lamp," by L. H. Rogers; "Steam Boilers; Their Equipment and Management," by Albert A. Cary; "Electrolysis," by Capt. William Brophy; "Evolution of Interior Conduits from an Electrical Standpoint," by Luther Stieringer. Lecture—"The Light of the Future," by D. McFarlan Moore. Topic—"The Desirability of a Standard Socket," discussion to be opened by Alfred Swan.

MORE EXHIBITORS FOR THE NATIONAL ELECTRICAL EXPOSITION.

In addition to the long list of exhibitors published last week we have received the following supplementary names: Metropolitan Tel. & Tel. Co., 15 Cortlandt street, New York; Interior Conduit & Ins. Co., 527 West Thirty-fourth street, New York; Fort Wayne Elec. Corporation, Fort Wayne, Ind.; Electrozone Co., Morris Building, New York; American Electric Heating Corporation, Sear Building, Boston; Bourne Scrymser Co., New York City; J. T. Case Engine Co., New Britain, Conn.; De Veau & Co., Frankfort street, New York; N. Y. Safety Steam Power Co., New York City; Schiff, Jordan & Co., Vienna, Austria; Spon & Chamberlain, New York City; Syracuse Storage Battery Co., Syracuse, N. Y.; Telluric Manufacturing Co., 52 New street, New York; Thomson Meter Co., Brooklyn, N. Y.; Wendell & McDuffie, Havemeyer Building, New York.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

The New England Passenger Association has granted a rate of a fare and one-third, on the certificate plan, from all points in their territory to New York and return, for all delegates and representatives attending the nineteenth convention of the National Electric Light Association, to be held in this city May 5, 6 and 7.

INHERENT DEFECTS IN FUSE METALS EXPERIMENTALLY CONSIDERED.

In his paper, entitled as above, read before the Franklin Institute, March 24, Mr. Walter E. Harrington emphasized the fact that fuse metals cannot be considered as the correct and safe means for protecting electric circuits. A fuse depends for its action upon the heating quality of the current; time and current combined melt fuses, C standing for current in amperes and T for time in seconds. A fuse does not operate the instant C becomes excessive, but it does when C^2T becomes excessive. A fuse is placed in a circuit to serve as a protection against some unforeseen accidental condition. In actual practice short circuits, crosses and grounds are almost exclusively the troubles met with, and do not exhibit the very conditions which fuses were designed to meet, namely, time and current. The current rises very high, far in excess of the rating and capacity of the fuse and the circuit the fuse is supposed to be protecting. It is the occurrence of short circuits which upsets the prevailing theories, as the fuse is intended only to meet a small percentage overloaded condition of circuit. Mr. Harrington's idea of the correct design of the magnetic circuit breaker is that it should have an inverse time element; its electro-magnetic mechanism should be designed to develop more energy than is necessary to trip its retaining catch; the additional energy developed should be applied directly to aid the opening of the switch; no springs should be permitted in its adjustment; insulation should not enter into the construction of the trigger or catch; all bearing pins and parts liable to corrosion or rust should be of phosphor-bronze and moving iron parts copper plated; and the armature or plunger should not act on the retaining catch or switch-arm unless a free preliminary movement precedes such action.

THE MEXICAN EXPOSITION.

As we have received some inquiries regarding the progress of the proposed Mexican Exposition, we have, for the benefit of our readers, obtained some facts in regard to the matter, which may be of interest to those intending to exhibit.

It seems that the exposition is not being undertaken by the Mexican government, but is in the hands of a private corporation who have obtained a concession or franchise from the government to arrange and conduct an exposition. The Mexican government has not given any official sanction to the scheme other than the franchise, nor will it appropriate any money to carry it on. Consequently if the exposition succeeds it will have to depend for funds entirely outside of the Mexican government.

The impression has been allowed to prevail throughout the United States that the exposition is being undertaken by the Mexican government and a number of States have already appointed commissions to represent them. Acting under this impression, Gov. Morton some time ago advised passing a bill in the New York legislature authorizing the appointment of a commission and appropriating money that the State may be suitable represented, but as nothing has since been done, it is quite likely that he has obtained the facts in the case and is deferring action on the matter. While we are not disposed to discourage this scheme at all—in fact, we believe an exposition in Mexico would be an advantage to both countries, yet judging from the Mexican papers and other sources of information it is not quite certain that the exposition will be held under the present auspices, and we would advise those who propose paying for space to wait a little, or at least to look into the probable chances of success which the exposition company has of carrying on such an undertaking. The date of opening has again been postponed until December 1 of this year, but as none of the buildings has been started it is very doubtful if it can be opened at that time.

A KELVIN JUBILEE.

On June 15 and 16, a celebration will take place at Glasgow to commemorate the completion by Lord Kelvin of his fiftieth year's tenure of the chair of natural philosophy at the University of Glasgow. A committee has been formed by the city and university to make arrangements, and bodies with which Lord Kelvin is connected have been asked to name representatives to whom invitations can be sent, for the occasion. President C. H. Wilmerding has appointed Mr. T. C. Martin to represent the National Electric Light Association at this interesting jubilee.

LECTURES ON LIGHTING OF BUILDINGS.

Mr. Clayton W. Pike, of the Falkenau Engineering Company, of Philadelphia, who delivered a course of four lectures before the senior class of the School of Architecture, Philadelphia, last year, will repeat the subject during March and April of this year in a series of six lectures.

The treatment of the subject covers modern engineering practice as to the various methods of lighting buildings, the necessary work to be done by the architect in preparing for the installation of electric lighting plants, and the relation of the architect's work to that of the electrical engineer.

AN ADDITION TO THE WHEATSTONE BRIDGE FOR THE DETERMINATION OF LOW RESISTANCES.

Mr. J. H. Reeves read a paper on the above subject before the Physical Society.

The piece of apparatus described can be used for measuring the resistance of metre lengths of wires of low resistance, the only additional apparatus required being a sensitive galvanometer, a Post Office form of resistance box, and a metre bridge. It differs from the ordinary Kelvin bridge in that instead of balancing by varying the length of the standard wire between the two contacts, the distance between these contacts is maintained constant, as is also the length of the wire which is being measured, and balance is obtained by altering other resistances in the network. The author has made a number of tests which show that by his arrangement the resistance of metre lengths of copper wires between the limits of No. 22 S. W. G. and a stranded cable of seven No. 16's can be determined with an accuracy of 0.1 per cent.

PERSONAL.

MR. P. E. SULLIVAN has been appointed superintendent of construction department, with the Standard Underground Cable Company, under Mr. George L. Wiley.

MR. F. L. FROST, of Albany, N. Y., has been appointed electrical expert in the State Hospitals at a salary of $2,500. His appointment comes through State Architect Perry, who took his name fom the civil service list.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS ISSUED MARCH 17, 1896.

Alarms and Signals:—

SWITCHBOARD SIGNAL. I. H. Farnham, Wellesley, Mass., 557,527. Filed Jan. 16, 1896.

Consists of a support in which is inclosed an electromagnet having an iron sheath, and hung by its upper end at the entrance of a cavity in the support, and in front of the electromagnet.

Galvanic Batteries:—

GALVANIC BATTERY. E. S. Boynton, Brooklyn, N. Y., 557,355. Filed Feb. 21, 1895.

Comprises two or more elements grouped in one receptacle and having an electrolyte common to all. Known as the "multivolt" battery.

GALVANIC BATTERY. E. S. Boynton, Brooklyn, N. Y., 557,356. Filed Sept. 13, 1895.

Similar to above.

Distribution:—

MULTIPLE SERIES SYSTEM OF ELECTRICAL DISTRIBUTION. F. B. Badt, Chicago, Ill., 557,099. Filed Sept. 25, 1895.

Means for operating translating devices in multiple series.

DISTRIBUTION OF ELECTRIC CURRENTS. I. Kitsee, Philadelphia, Pa., 557,398. Filed Sept. 16, 1895.

Employs resistance varying with the varying need of current.

MEANS FOR TRANSMITTING ELECTRICAL ENERGY. T. W. Onderdonk, New York, 557,422. Filed April 9, 1895.

Consists principally of a motor shaft provided with a circuit breaker and an electromagnetic motor for operating a tool.

Dynamos and Motors:—

COMMUTATOR FOR HIGH VOLTAGE DYNAMOS. A. J. Oehring and H. H. Wait, Chicago, Ill., 557,218. Filed Aug. 20, 1895.

The segments are fastened by means of screws to the face of a wood disc.

FAN MOTOR. R. H. Hassler, Dayton, O., 557,384. Filed Nov. 27, 1895.

An electric motor with field and armature revolving in opposite directions in a vertical plane, a wheel attached to the armature and a second wheel attached to the field, the two wheels adapted to drive by friction a third wheel revolving in a horizontal plane and attached to a ventilating plane.

Lamps and Appurtenances:—

ELECTRIC ARC LAMP. W. D. Ray, Chicago, Ill., 557,229. Filed July 11, 1894.

Employs curved carbons.

CARBON HOLDER FOR ARC LAMPS. C. A. Pfluger, Chicago, Ill., 557,518. Filed Aug. 7, 1895.

Two pivoted clamping jaws with thumb screws, one adapted to control each jaw, and both to be moved simultaneously when desired.

SHADE FOR INCANDESCENT ELECTRIC LAMPS. S. O. Richardson, Jr., Toledo, O., 557,342. Filed Nov. 1, 1892.

A bulb formed of alternate series of horizontal thick and thin portions, the outer and inner surfaces of the said thick portions being parallel.

Measurement:—

ELECTRIC METER. C. P. Steinmetz, Schenectady, N. Y., 557,164. Filed Jan. 15, 1896.

A meter for a monocyclic system, consisting of a field magnet supplied by a resultant source of energy, transformers for establishing phase relations corresponding to those of the main line, and an armature supplied by the transformer.

Miscellaneous:—

MAGNETIC ORE SEPARATOR. O. M. Graves, North Yakima, Wash., 557,121. Filed June 17, 1895.

Magnetic needles projecting from an endless carrier, and a vertically pivoted oscillating hammer, in operative proximity to the edge of the needle carrier.

ELECTRICAL DENTAL PLUGGER. P. R. Skinner, Oneonta, N. Y., 557,159. Filed May 6, 1895.

Details of construction.

THERMOSTAT. W. S. Johnson, Milwaukee, Wis., 557,272. Filed March 24, 1894.

A single piece of platinum is made to operate as a contact piece in connection with both of the contact screws.

CABLE RAILROAD. W. M. Wood and J. C. Miller, Elmira, N. Y., 557,320. Filed Aug. 26, 1895.

Devices which can be operated quickly to close or open an electric circuit through suitable mechanism, located at the power house, to stop the cable quickly in case of an accident.

ART OF ELECTRIC DYEING. G. D. Burton, Boston, Mass., 557,324. Filed Sept. 25, 1894.

Consists in passing a current at 40 volts or more through the dyeing liquor, thus expanding the fibers of the material to be dyed.

ART OF AND APPARATUS FOR ELECTRO-DYEING. G. D. Burton, Boston, Mass., 557,325. Filed Oct. 31, 1894.

Similar to above.

ART OF AND APPARATUS FOR ELECTRIC DYEING AND SHRINKING. G. D. Burton, Boston, Mass., 557,326. Filed Feb. 25, 1895.

Similar to above.

CIGAR LIGHTER. J. Frye, Philadelphia, Pa., 557,375. Filed July 16, 1895.

An electric spark is employed to ignite a wick saturated with alcohol or similar material.

ELECTRICAL LIGHTING APPARATUS. R. A. Schoenberg, J. W. Flucker, A. N. Keedwell, New York, 557,434. Filed Dec. 5, 1895.

Gas lighting apparatus designed especially for burners of the Welsbach type.

ELECTRIC FLASH LIGHT APPARATUS. G. R. Lawrence, Chicago, Ill., 557,403. Filed May 17, 1895.

An electric conductor and a number of fuses adapted to complete the circuit on the pans or arms and to ignite the powder.

ELECTRIC GATE OPERATING MECHANISM. F. J. Dyett, Ilion, N. Y., 557,497. Filed Nov. 1, 1893.

A driving shaft having the reversing gears connected with the motor shaft, a clutch operating to alternately make one or the other of the gears fast with the driving shaft.

Railway and Appliances:—

TROLLEY POLE SUPPORT. N. H. Davis, Philadelphia, Pa., 557,114. Filed Nov. 8, 1895.

A pivoted spring support.

RAIL BOND AND ELECTRICAL CONNECTOR. C. E. Moore, Chicago, Ill., 557,139. Filed Oct. 9, 1895.

A flanged rail bond provided with a tapered sleeve adjusted by means of a screw.

RAIL BOND AND CONNECTION. E. A. Turner, Chicago, Ill., 557,174. Filed Sept. 7, 1895.

Sleeves driven into the rail in one direction and adapted to receive the enlarged end bond when inserted in the other direction.

ELECTRIC RAILWAY. P. B. Delany, South Orange, N. J., 557,258. Filed Oct. 10, 1892.

An electric heating wire arranged within the conduit and a conductor enveloping or partly enveloping the heating wire.

ELECTRIC CAR HEATER. J. G. Noyes, Milford, Conn., 557,282. Filed Aug. 16, 1895.

A corrugated heater-body containing electrical conductors embedded in cement in the corrugations on one face and perforations between the corrugations.

TROLLEY FOR ELECTRIC RAILWAYS. H. A. Seymour, Washington, D. C., 557,442. Filed Feb. 1, 1896.

An electromagnet adapted to maintain the trolley in good contact with the conductor.

RAILWAY SWITCH. L. A. Osborne, Newark, N. J., 557,338. Filed Nov. 26, 1894.

A solenoid actuating operating pawl, and means for giving return movement to the solenoid core and its attachments.

AUTOMATIC SWITCH. L. A. Osborne, Newark, N. J., 557,339. Filed March 4, 1894.

Means for energizing the coils of a ratchet wheel in mechanical connection with the frog carrier.

Regulation:—

REGULATING ELECTRIC MOTORS. J. Burke, Newark, N. J., 557,185. Filed Sept. 4, 1895.

Utilizes an auxiliary electromotive force to assist or oppose the line potential.

Switches, Cut-Outs, etc:

SNAP SWITCH. J. S. Gibbs, Hartford, Conn., 557,198. Filed Jan. 20, 1896.

Details of construction.

ELECTRIC SWITCH. C. G. Perkins, Hartford, Conn., 557,224. Filed Jan. 2, 1894.

Details of construction.

ELECTRIC CUT-OUT. R. G. Davis, Brooklyn, N. Y., and A. M. Torrance, Bennington, Vt., 557,257. Filed July 5, 1893.

A pivoted arm is adopted to be thrown out of engagement with the contact post.

RHEOSTAT. H. E. Heath, Windsor, Conn., 557,386. Filed Dec. 26, 1895.

Makes use of flexible non-conducting wire holders, with which the wire is interwoven.

Telephones:—

APPARATUS FOR TELEPHONE LINES. C. E. Scribner, Chicago, Ill., 557,153. Filed Aug. 17, 1895.

Permits the use on combined metallic and ground return circuits of automatic signals at the central station controlled by the switch hook at the sub-station.

APPARATUS FOR TELEPHONE LINES. C. E. Scribner, Chicago, Ill., 557,154. Filed Aug. 17, 1895.

A storage battery at the sub-station and means for charging from the central station.

TELEPHONE SWITCH AND SUPPORT. E. C. Paramore, Philadelphia, Pa., 557,284. Filed April 24, 1895.

The removal of receiver opens bell circuit without aid of springs.

OBITUARY.

WILLIAM BOARDMAN TOBEY.

THE sad news has reached us of the death at Guayaquil, Ecuador, of Mr. Wm. Boardman Tobey, of Pittsfield, Mass. Particulars as to the cause of his death are missing, but it is supposed that he fell a victim to the virulent fevers to which foreigners in these Southern countries only too frequently succumb.

Mr. Tobey, though only 27 years old at the time of his death, was on the high road to a brilliant career. After taking the degree of electrical engineer at Cornell, in 1889, he entered the Stanley Laboratory at Pittsfield, Mass., where he assisted actively in the design and construction of the well-known Stanley alternating-current apparatus. In the fall of 1894, Mr. Tobey became the manager of the S. K. C. Specialty Company, at Pittsfield, which position he held until the beginning of this year, when he resigned to accept the management of the Ecuador General Electric Company. It was while making a survey of the work to be inaugurated at Guayaquil that Mr. Tobey was stricken down.

In 1894 Mr. Tobey married Mrs. Frances Cooley Prescott, who survives him, and to whom, as well as the parents of the deceased, we tender our deepest sympathy. Those who were privileged to know Mr. Tobey will regret the untimely death of one so able and withal so courteous to all who came in contact with him.

W. T. M. MOTTRAM.

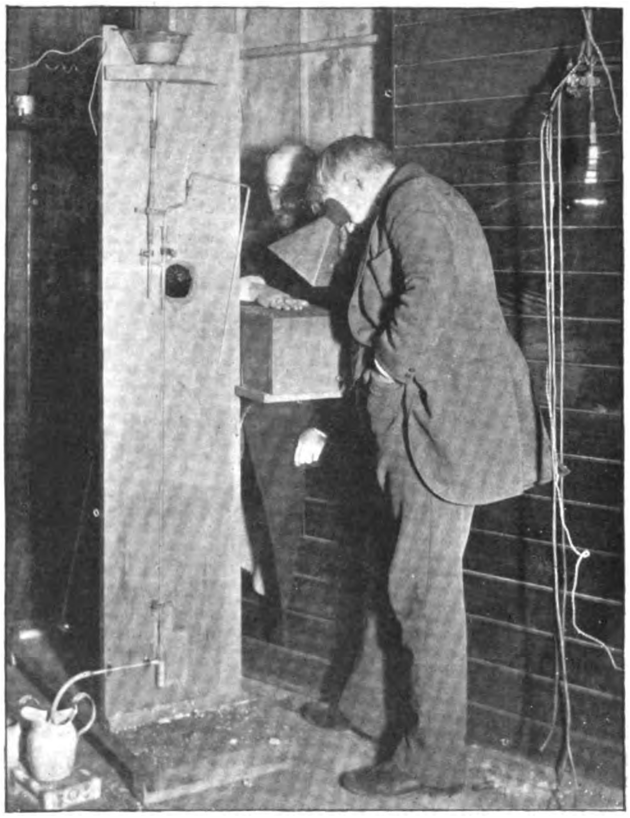
We learn with deep regret the news of the death at New Orleans of Mr. W. T. M. Mottram, a young Englishman of considerable ability, who had been for several years past actively engaged in electrical work in this country. He studied under

Professors Ayrton and S. P. Thompson in London, and then as an assistant to Mr. W. J. Hammer, took part in the installation of the Edison Holborn Viaduct station in 1881. He was also employed on the first plant installed in the British Houses of Parliament. After doing work in Germany for the Edison Company, he came to this country and was then for some time associated with the Edison and Sprague interests. He was at one time in charge of the Wilmington and New Orleans Edison stations. Of late years he had drifted into the contracting branch of work, and being a good engineer was able to leave behind him an excellent record in the design and construction of numerous plants. He was of amiable disposition and his fidelity to duty won him a great many friends. He leaves a widow.

Exhibition Notes.

EDISON'S PORTABLE X-RAY APPARATUS.

In addition to devising his simple and highly ingenious fluoroscope, based upon the properties of tungstate of calcium, enabling anybody to examine at will any object, whether moving or still, under the Röntgen ray, Mr. Edison has now put together a simple compact set of apparatus, by means of which the whole fluoroscopic and ray outfit can be carried from point to point and utilized on the spot for surgical operations and physical introspection. Mr. Edison is now building four of these sets which will be operated by his own staff in the Röntgen ray exhibit which he has very generously consented to make at the National Electrical Exposition in this city.



Portable Edison Fluoroscope Apparatus to be Used at the Electrical Exposition.

The picture shown herewith, taken from a flashlight photograph, made last week, is of Mr. Edison himself, at the Orange laboratory, studying a hand by means of his fluoroscope. The hand rests on a box which contains the battery, the induction coil and the Crookes tube. When the current from the battery is switched on to the coil and tube, the mercury pump seen on the upright board is also started, so that the tube is undergoing exhaustion while in operation. Mr. Edison has found that the tube works much better while thus used.

As will be seen, this apparatus can be set on wheels and rolled around a hospital, or put on the cars and shipped to the scene of a railroad wreck. At the exposition, people will be allowed to look at their own hands on the box, if they choose; but if they linger the circuit will be broken. In this way the procession will be kept moving. The fluoroscope will be of the hand size illustrated in "The Electrical Engineer" of April 1, but other sizes will be exhibited as well as those which surgeons can slip on the head so as to leave both hands free.

WHAT EXHIBITORS WILL DO.

Active preparations for the approaching exhibition at the Grand Central Palace are going on and many exhibitors, who have their plans well advanced, are ready to state what they propose to do.

The General Electric Company are preparing a very fine exhibit, based on the lines of their display at Atlanta.

The New York Edison Company, as already announced, has undertaken to show on a broad and comprehensive scale the many uses to which central station current can be put in the office, factory, hall, street and home.

The Abendroth & Root Manufacturing Company are putting in a fine boiler plant, which will not only supply steam to the exhibits of engines, but will embody some remarkable features of novelty in its care and management. It will probably be one of the most striking features of the show.

The Weston Engine Company, of Painted Post, N. Y., are about placing on the market a new engine, which will be shown first at this exhibition. It is to be called the "Imperial Self-Oiling" engine, and it will drive a dynamo of one of the leading makes.

The Bryant Electric Company will not go in for an elaborate display, but will show their standard sockets, switches, etc.

The Crocker-Wheeler Electric Company are not ready to announce their plans, but have a very fine and large exhibit in preparation, which will admirably illustrate the various elements and details of current generation and power transmission.

The Ball & Wood Engine Company will show one of their standard simple engines which they are completing for the large set of same to go in the new Siegel-Cooper building on Sixth avenue. It will be direct connected to a Siemens-Halske generator. It will be fitted with all their latest improvements.

The Carpenter Enamel Rheostat Company will display, in use, various types and sizes of their field regulators, theatre dimmers, motor starters, motor regulators, reversing controllers for traveling cranes and elevators, etc.; also automatic rheostats for opening circuit both from failure of current and upon overload. There will also be a full line of electrically heated tools, such as soldering irons of various sizes and for all voltages up to 500; also flatirons, curling iron heaters and other new and novel apparatus.

The Bishop Gutta Percha Company will make an exhibit, including a general assortment of their wires and cables as used in house wiring and underground work. They will also show typical, practical examples of their several styles of cables used for lighting buoys, for drawbridges on electric roads, cables and wires made for battleships, life-saving signal service, etc. They will show in addition to these gutta-percha and india-rubber, both crude and in different stages of preparation and manufacture. They will probably include also some other features of their work interesting to the public.

The Calculagraph Company will have a working section of telephone board set up in their space with which to illustrate the excellent features of their apparatus for "keeping tab" on elapsed time. There will be other features of interest and novelty.

Mr. John Burry will exhibit his improved printing telegraph system as operated by the Stock Quotation Telegraph Company in New York. The apparatus will comprise a printing telegraph transmitter of the sunflower pattern with a capacity for controlling 2,000 tickers; the relay used in connection with the transmitter, and a keyboard. The whole will be in working operation, thus giving an excellent opportunity for inspecting and studying the system.

NEW YORK STATE ELECTRIC CO.

Mr. W. H. Bonnell, the treasurer of the New York State Electric Company, of Youngstown, O., makers of incandescent lamps, informs us that they have just made the shipment to Liverpool of 1,000 lamps, being the first installment of a large order. The lamps were all shipped in one box, which the company have specially designed for their export trade. This box is made of 1¼-inch Norway pine, divided into three compartments, and so devised as to hold the lamps free from risk of breakage and to take up the least possible number of cubic inches. The case is bound outside with steel.

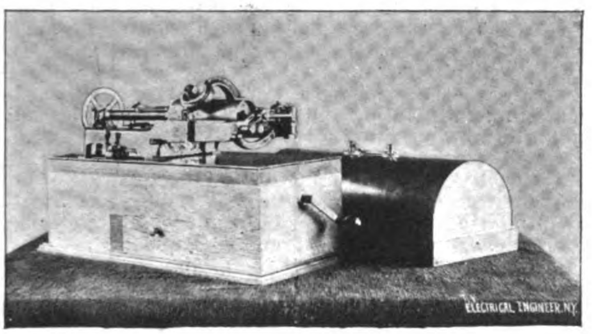
Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

A NEW EDISON PHONOGRAPH.

THE recent announcement of the interesting news that Mr. Edison had bought back from the receiver of the North American Phonograph Company his own property and rights, is followed up by the placing on the market of the new Edison phonograph here illustrated. This machine is being built at the Edison Phonograph Works, at Orange, N. J., and will be handled by the National Phonograph Company, which is now establishing agencies everywhere for its sale.

The new machine conforms in a general way to the older type, but it has two decided elements of novelty. One is that it is operated by a spring motor, and the other that it is to be sold for about $40, thus placing the instrument within the reach of everybody, as a very formidable rival to the limited musical box. Mr. Edison has found that many people are still unable to avail themselves of street current for the dearer phonograph



THE NEW EDISON PHONOGRAPH.

run by electric motor, or else are very averse to bothering with primary batteries, which few of them understand. Hence, he has deemed it advisable to build this new phonograph, which is driven by a simple double spring clockwork mechanism packed away snugly under the lid of the box. The phonograph is similar in design to the standard instrument, but is in reality lighter and thus runs with less frictional loss. The thread on the main shaft is 100 to the inch, so that the standard music and recitation cylinders, of which there are now thousands, can be used. It is so arranged that multiple tubes can be employed, enabling several persons to listen at once; and it is also furnished, when desired, with a large horn and stand, answering the needs of a large audience. The size over all is 15½ by 7 inches by 10¾ inches in height. The machine is fitted with a handsome oak case, having a removable halfround top and a drawer for supplies. The whole thing is remarkably compact, and the results given by the machine are wonderful in clearness and sweetness of tone. The machine is fitted for reproducing only, but for a small extra charge it is also built to record, or to do both.

J. H. McEWEN MFG. CO.

Those who are contemplating the installation of steam and electrical apparatus should send for the handsome catalogue issued by the J. H. McEwen Manufacturing Company, Church and Cortlandt streets, New York City. This company report having recently closed contracts for the following apparatus: Two railroad generators, 150 k. w. capacity, D. C. to 12 x 23 x 36 tandem compound engine for the Hingham, Mass., Electric Railroad; one 150-kilowatt generator, D. C. to 18 x 18 simple engine, for the Morris Coal Company, Jobs, O.; one 85-kilowatt belted generator, and one 15 x 16 simple engine for the Carbondale Fuel Company, Des Moines, Ia.; one 13 x 14 simple engine for Miner-Hillard Milling Company, Miner's Mills, Pa.; one 15 x 16 simple engine for O'Neill & Patterson, Bunola, Pa.; one 16 x 16 simple engine for Ellsworth-Morris, Sutterville, Pa.; one 16 x 16 simple engine for W. J. Smith, Mount Pleasant Mines, Scranton, Pa.; one 16 x 16 simple engine, New York and Pennsylvania Company, Johnsonburg, Pa.; two 200-kilowatt generators, D. C. to 14 x 28 x 20 tandem compound engine, for Frankford & Tacony Street Railroad, Tacony, Pa.; one 10 x 10 simple engine for Charles S. Solomon & Co., St. James Hotel, Washington, D. C.; one 10 x 10 and one 12 x 12 simple engine for Dr. J. S. Gilbert, Bordentown, N. J.; one 30-kilowatt generator, D. C. to 9 x 8 simple engine, Kunkle Bros., Pittsburg, Pa.; one 8 x 10 simple engine, American Glue Company, Springdale, Pa.; one 8 x 10 simple engine, Kunkle Bros., Pittsburg facturing Company, Chicago, Ill.; one 25-kilowatt generator, D. C. to 8 x 10 engine, Lea & Carroll, Pittsburg, Pa.; one 25-kilowatt belted generator, H. W. Johns Company, New York; one 100-kilowatt belted generator, Link-Belt Machinery Company, Chicago, Ill.; one 80-kilowatt belted generator, Westinghouse Light, Heat and Power Company, York, Pa.; one 50-kilowatt generator, D. C. to 12 x 12 engine, German-American Brewing Company, Buffalo, N. Y.; one 75-kilowatt generator, D. C. to 13 x 14 simple engine, Monongahela House, Pittsburg, Pa.; one 200-kilowatt belted generator, Armour Company, Chicago, Ill.; one 60-kilowatt generator for V. Henry Rothschild & Co., for factory at Trenton, N. J.; one 120-kilowatt belted generator for Jeffrey Manufacturing Company, Columbus, O.

THE INTERNATIONAL INVENTIONS ASSOCIATION.

WE notice in "La Bourse des Brevets," published in Paris, an article announcing the fact that two companies have recently been formed, one in London and the other in Paris, under the combined name of the International Inventions Association. The object of these companies is that of examining and negotiating the sale of inventions upon a mutual basis. The Inventions Development Company, of 45 Broadway, this city, which was formed last year for a somewhat similar purpose, has recently consummated an arrangement whereby it will represent the United States, Canada and South America in a combination which appears to be very far-reaching in its scope.

The Paris company has agencies in the following cities on the European continent: St. Petersburg, Berlin, Brussels, Vienna, Zurich, Milan and Madrid.

The London company has agencies in the following cities: Bombay, Calcutta, Sydney, Melbourne, Brisbane, Cape Town and Auckland.

The New York company has agencies in Canada and South America.

We understand that the Inventions Development Company has among its stock-holders many very wealthy and prominent business men in this and other cities of the United States. The combined companies do not propose acting as patent attorneys, but intend confining their business exclusively to negotiating the sale of meritorious inventions.

The general basis of operation is that inventions submitted to any one branch of the association must pass through the branch of the company through which it emanated; thus, all the inventions submitted to the English and French companies must pass through the American company by which it is first investigated.

The general principle appears decidedly good in view of the experience and ability connected with the management and should prove not only of considerable value to inventors but turn out profitable to those connected with the undertaking.

One great advantage to purchasers of patents is that they must have passed through a most thorough examination not only by the branch of the association which first sends the patent, but all those to whom it is sent, thus forming practically a triple investigation. Patentees of meritorious inventions ought to find powerful allies in these companies.

SUNBEAM LAMPS FOR SIGNS AND DECORATIVE LIGHTING.

THE Sunbeam Incandescent Lamp Company, of Chicago, is making a specialty of lamps consuming a small amount of energy for use in sign and decorative lighting. It is claimed that these lamps not only have the advantage of the saving in energy, which in a large sign is a consideration of great importance, but that for the purpose they are superior to lamps of higher candle-power, all other things being equal. It is claimed that the effect of the glare of the lamp of larger candle-power is to blur the sign while the glow of the lamp of smaller candle-power will show the sign more clearly.

Tests have recently been made by fitting different letters of the same sign with lamps of different candle-powers and the better effect of the lamp of small candle-power has thus been fully demonstrated. A four-candle-power (20-watt) lamp is the one usually used for signs and is furnished in all voltages. The Sunbeam Company is also making a two-candle-power (10-watt) lamp in voltages from 50 to 60. These have bases to fit the standard sockets and are to be connected in multiple. The company has already filled orders received from all parts of the world, and it is claimed that there is no other lamp company that has been able to produce a lamp of such high voltage and consuming so small an amount of energy.

ELECTRIC HEAT ALARMS FOR A MAMMOTH BOSTON WAREHOUSE.

Plans have been completed for a mammoth brick storage warehouse to be erected for the Massachusetts Fireproof Storage and Warehouse Company on Bryant street, Boston. The proposed structure will be seven stories high. The foundations for this great building will be of granite, while the walls of the superstructure for the first two stories will be twenty-eight inches thick, and up to the top stories twenty inches. The estimated cost will be about $350,000 above the ground.

We learn from F. S. Palmer, general manager of the Electric Heat-Alarm Company, that a contract has just been closed to equip this property with their automatic fire alarm system. This equipment will be entirely different from anything of which we have knowledge. For instance, the regular testing and recording apparatus will be in the office, an annunciator for the various floors, and a watchman's twenty-four-hour register in series with the doors; said doors in series in the negative or blue wire. The thermostats are arranged in groups, and connected to a 70-point annunciator in the office. There will be a short-circuit box on each floor, plainly marked "Break glass in case of fire." This arrangement for the doors will be found even on the office door so the watchman, after 6 o'clock at night, cannot go out of the building without a record of the same being made in the office. He can go from the fire room to the office, and will be required to make a register of his arrival in the office and in the engine room. Should a door be opened on any of the floors, it announces the floor on the annunciator in the office; and the time said door was opened will be indicated on the 24-hour register.

This building will be entirely fireproof and should spontaneous combustion occur in any of the store rooms, it will be announced on the annunciator in the office. The watchman will then go to the floor on which the fire exists, and as he passes through the doors it will be announced in the office, and the time registered. When he gets back to the office, a test that any one can make will prove to him whether or not he has closed the doors. If the stylus punches, it proves the doors are closed. If not, it proves that he has left one open. An auxiliary test shows him on which floor he has left this door open.

In connection with this system they will have an alarm to the police station and to the fire department, by a partial underground system, so that should burglars desire to get into the building, they will have to go to a pole or a street some distance from the building, go up through numerous other wires, and cut four other wires belonging to those of the Massachusetts storage warehouse. From this pole, the wires are carried in underground conduits by the New England Telephone Co., to the building located on Bryant street.

POWER FOR THE HOGBACK TUNNEL, COLORADO.

The General Electric Company's office at Denver is furnishing the necessary electrical machinery for the construction of the tunnel through the hogback south of Pike's Peak, which is to form a portion of the new waterworks system of Colorado Springs. This enterprise is the largest ever undertaken with electricity as the motive power in the West, and among the largest in the country.

The tunnel is to be 6,400 feet long and will be run from both enus. The air compressors are to be run by a 75-horse-power three-phase motor. The generating station is to be erected a short distance above the Iron Springs Hotel at Manitou and the water necessary for the generation of the electricity is to be taken from the pipe line which now supplies Colorado Springs with water, and after being used for this purpose will be again conducted to the pipe line. The water has a fall at the site of the power station of 700 feet. The power is to be generated by a 150 kilowatt, three-phase generator, which will develop a force of 3,600 volts. The current will be transmitted about eight miles, and will be used to run the air compressors, supplying lights and for other necessary purposes.

The water for the system is to be taken from the creeks on the western slope of Pike's Peak, and will be conducted through this tunnel which will be made as small as possible, and leave room for the men to work, probably about 3 x 5 feet. The work of constructing the power station, erecting poles, stringing wires, etc., will be commenced at once, and the machinery will be shipped in about five or six weeks. The contract has been awarded to Wilson & Jackson.

MR. JOHN BONNEY, late of the Telegraph Construction and Maintenance Company, has been appointed electrical engineer in electrical charge of the Cuba Submarine Telegraph Companys lines, with headquarters at Cienfuegos.

NEW YORK NOTES.

RICKETTS & BANKS, of 104 John street, New York, after having made careful experiments, are now ready to supply the best crystalline form of tungstate of calcium for perfect fluorescence. Their material has been tested and approved by many of the most prominent workers on Röntgen ray development and has given universal satisfaction.

THE CALCULAGRAPH COMPANY have recently received orders to equip with their instruments for recording elapsed time, telephone exchanges in the following named cities and towns, viz.: Boston, Fall River, New Bedford, Brooklyn, Taunton, New Haven, Baltimore, Philadelphia, Milwaukee, Maumee, Cincinnati, Evansville, Indianapolis, Terre Haute, Altoona, Harrisburg, Hazelton, Temple, Tadmor, O., and East Onondaga.

UNDERGROUND CABLES IN TOLEDO, O.—The National Underground Cable Company has just been awarded a contract by the Toledo Traction Company, for all the underground cables to be used by the latter company during the year 1896. This contract for underground cables is one of the largest ever given out in the United States, and covers cables for several kinds of service, including railway feeder, electric light and power distribution, and when finished will be the only system in the world in which series arc circuits and the three-wire system will be distributed from the same station. The distribution will be done from one immense central station, and the sizes of cables to be used from No. 6 B & S. G. to 1,000,000 circular mils.

The contract of the National Company covers also all the work of laying and jointing and connecting of the cables and the furnishing of all apparatus to be used in connection with the underground system.

The National Conduit Manufacturing Company, the associate company of the National Underground Cable Company, furnished all the underground conduits and built the complete subway system for the Toledo Traction Company.

As a result of its continuously increasing business, the National Company's cable factories at Harrison, N. J., and conduit factories at Hastings-on-Hudson, N. Y., are compelled to run night and day to keep up with orders.

THE RUSHMORE DYNAMO WORKS, of Jersey City, N. J., report that they are fitting up the gunboats of several South American countries with their searchlights, and that inquiries are arriving from all parts of the world, in response to their announcements in the electrical papers.

NEWS ITEMS.

THE WESTINGHOUSE MACHINE COMPANY'S orders for March include three vertical cross-compound engines, each 1,600 h. p. for the Allegheny County Light Co. station, Pittsburg, Pa.

THE CUTTER ELECTRICAL & MFG. CO., 1112 Sansom street, Philadelphia, announce that they have in their printer's hands a beautifully illustrated catalogue of their C-S flush switches and accessories. This promises to be the most elaborate catalogue devoted to this subject, and will be sent post paid to all interested. They are also preparing an illustrated catalogue of the I. T. E. circuit breaker, about which we are hearing favorable comments on all sides. This will be ready early in May.

AHEARN & SOPER.—Arrangements have been made by which Messrs. Ahearn & Soper, Ottawa, Canada, will represent the exclusive sale of the Westinghouse Electric & Manufacturing Company's apparatus in the Dominion of Canada.

WURTS' LIGHTNING ARRESTERS.—Although the season has scarcely opened, the demand for Wurts' lightning arresters that is being made on the Westinghouse Electric & Manufacturing Co. bids fair to be phenomenal. How popular this lightning arrester has become, and how well it has proved its efficiency, may be gathered from the fact that during 1894 the Westinghouse company sold nine thousand arresters, and in 1895 twelve thousand, while every indication for the present year promises to double the sales of last year.

PROBATING FRANKLIN'S WILL.

The will of Benjamin Franklin was allowed in the Suffolk County, Massachusetts, Probate Court to-day by Judge Grant on petition of Mayor Quincy, of Boston, as a foreign will, having been probated a century ago in the Orphans' Court in Philadelphia. The probate of the will now is deemed necessary in view of a legal disposition of the "Franklin Fund," which was created by the will of Franklin, and now amounts to several hundred thousand dollars. There was no opposition to the probate.

Department News Items will be found in advertising pages.

THE

Electrical Engineer.

Vol. XXI. APRIL 15, 1896. No. 415.

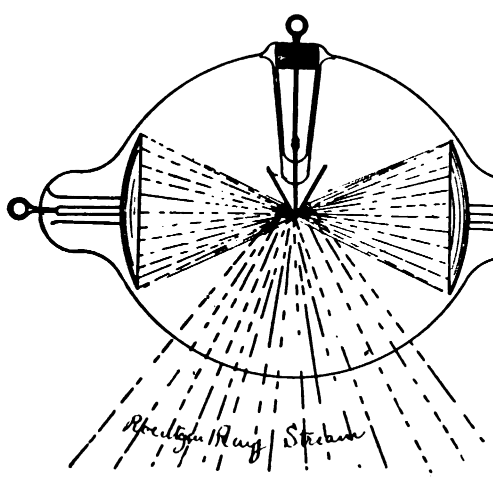
Electric Lighting.

A STANDARD FORM OF ROENTGEN RAY TUBE.

Elihu Thomson

MY attention has been called to an article by Mr. T. A. Edison on "Are Röntgen Rays Due to Sound Waves?" published in "The Electrical Engineer" of April 8. In the first place, I would say that I thoroughly appreciate the arguments advanced by Mr. Edison in relation to this matter, but if I understand him to put forward the idea that Röntgen rays are simply sound waves of very high or inaudible pitch in air, solids, gases, or liquids, then I think there are certain facts which negative any supposition of this kind. Röntgen rays traverse without apparent absorption highly exhausted bulbs, or bulbs which contain the least possible air or gas. This fact alone would point to the Röntgen ray as propagated by ether and not as a sound wave in air. It would be very difficult to explain on a sound-wave theory how some substances are electrified positively and others negatively by Röntgen rays.

If Mr. Edison means that the waves are longitudinal waves, and not transverse waves in the ether, and, therefore, analagous to sound waves, this, of course, would not be a new view, as it has been advanced by Prof. Röntgen himself, though there are many facts which have since been discovered which



PROF. ELIHU THOMSON'S STANDARD RÖNTGEN RAY TUBE.

tend to favor the idea that Röntgen rays are simply very high pitch waves similar to light waves; that is, transverse waves in the ether.

The experiments with the steel plate which Mr. Edison describes appear to me to indicate something in the nature of diffraction. Some of the earliest Röntgen pictures which I made gave evidence of a slight amount of reflection of the rays at high angles, at least the appearances presented, could only be explained on the idea of reflection. The rays found in the shadow towards the edge of the steel plate in the experiments of Mr. Edison may have been due to diffraction.

My observations in regard to the Röntgen rays from tubes with even so low a vacuum as to give striae coincide with those of Mr. Edison—that such tubes will even give Röntgen rays when subjected to very sudden discharges, that is, discharges in which the potential wave thrown upon the tube is abrupt. Hence, a Wimshurst machine will excite such a tube where an induction coil may not. The sharpness of the shadow given by a Crookes tube will depend upon the definiteness of the bombardment, that is, upon some particular spot alone becoming the source of the Röntgen rays, and upon the character of the discharge, which, if oscillatory in character will, in many tubes, produce two sources of emanation of Röntgen rays, and this, of course, will give confusion in the image. An abrupt break in the Ruhmkorff would naturally tend to give prominence to a particular direction of discharge, and, hence, conduce to making one of the terminals more entirely a cathode than with a less abrupt break in the primary, sharpness being the natural result.

I may add that the observations which have up to this time been made as to the source of the rays point to the fact that the cathode rays must strike some surface, which then becomes the Röntgen ray source. My own observations make me think that if the bombarded surface is of such a dense metal as platinum, which does not fluoresce, the rays will be more energetic. Bearing in mind these considerations and that it is desirable to possess Crookes tubes which are of standard make and adapted for use with high frequency apparatus, Ruhmkorff coils with oscillatory or uni-directional discharge, or with Wimshurst or Holtz machines, I have proposed as a standard tube one which is represented in the accompanying sketch.

The structure consists of a bulb, at opposite sides of which are mounted concave aluminum discs supported on wires sealed through the glass. The foci of these concave electrodes coincide nearly at the center of the bulb, at which point is located a V-shaped sheet of platinum, iron, or other piece of metal, such as a small piece of iridium. This could be supported in any way desired, but it may be suggested as a convenience that it be mounted on a third or middle terminal, so that it can be made an anode. In using this tube with high frequency currents the two cup-shaped terminals are attached to the source of electric currents, which alternately become cathode during the discharges, and cause the Röntgen rays to be emitted from the apex of the platinum sheet or from the surface of the piece of metal placed at the common focus. With oscillatory currents from a Ruhmkorff coil the same connections may be used, and even when the discharges are uni-directional the connection of either cup-shaped terminal as a cathode makes the tube effective, but in this case the middle terminal may be made the anode and the other or cup-shaped terminal a double cathode, and thus give the greatest amount of cathode surface, with but a short distance to be traversed by the discharges, while the sharpness of the focus, and consequently the definition obtainable with the Röntgen rays remains unimpaired. If the vacuum in such a tube is too low, it is also possible to raise it quickly by constituting the middle terminal a cathode for a time, in which case metal would be carried therefrom and deposited on the side of the bulb in a very fine state of subdivision and quickly absorb the residual gas. During the working of the tube it can sometimes be restored by simply heating the tube to a high temperature.

WAS THIS LAND LIT BY X-RAYS?

A reader of "The Electrical Engineer" sends us the following bit of folk-lore taken from the book entitled "Stray Leaves from Strange Literature," by Lafcadio Hearn: "There is in the ancient Finnish tongue a strange book written, called 'Kalewala,' a book of runes, treating about the beginning of the world, and about the god-smiths who first wrought the foundations of the sky, and about the witches and enchanters of the farthest North. Of witches Louhi was among the greatest, and her daughter was wooed by gods and heroes, even by Wainamoinen the mightiest. * * * So fair was the virgin that her beauty gave light like the moon; so white were her bones that their whiteness glimmered through the transparency of her flesh; so clear was the ivory of her bones that the marrow could be seen within them. * * * And the story of how Wainamoinen built a boat that he might sail to woo the virgin, is told in the runes of the Kalewala."

ROENTGEN RAY LAMPS AND OTHER EXPERIMENTS.

BY

Thomas A. Edison.

A VACUUM tube, the inner portion of which has fused to it crystals of tungstate of calcium when exhausted to the X-ray stage, gives out scarcely any of the rays; on the other hand, the tubes shine with a splendid white fluorescence. We have here a true fluorescent lamp, possibly commercial, as a very small bulk gave in the photometer 2½ candle power with an extremely small amount of energy. The white light is of a character not unpleasant, but quite the contrary. The spectroscope reveals the reason; the spectrum has strong red rays.

Tubes with aluminum electrodes become coated with transparent aluminum, which, as time goes on, gets so thick as to become visible. The X-ray is greatly diminished, not, I think, so much on account of absorption of the wave after generation, but through lack of elasticity, the concussive action or energy being absorbed by deforming the aluminum.

Silicon carbide is a conductor for high-tension current, a fact previously noted by Tesla. It is a very good conductor. I have substituted pieces of the carbide for aluminum; no air comes therefrom; it does not absorb air; it cannot be melted, nor does it blacken the glass. The voltage can be increased to a point where the glass melts. It may possibly prove the most practical substance for electrodes in high vacua. The only difficulty is the contact between the carbide and platinum wire.

With all glass used for making bulbs the sodium line shows in the spectroscope; there is evidently a decomposition due to the current, electrolytic or otherwise. Combustion tube glass has the least; lime soda glass, that is, the glass used for dry plate photography, has the most. This latter glass is the most transparent to the X-ray, but the continuous decomposition of the glass makes it almost impossible to maintain a vacuum except when connected to the pump, and even then the effect of the current is greater in producing gas than the capacity of the pump to exhaust, but the ray is very powerful.

Experiments were made with over twelve hundred substances in the form of crystals and precipitates. Not one fluoresces through thick cardboard when the sources of energy are the arc light, a six-inch spark in air, a vacuum tube with vacuum so high that a ten-inch spark leaves it dark, and the direct rays of the sun from 11 till 2 p. m.

Another fact supporting the theory that the X-ray is a wave due to concussion is that crystals of calcium tungstate are very sensitive to agitation or slight friction, giving off light. It is also of interest to note that by a properly arranged sensitive flame and phonographic listening tubes, my assistants have made it responsive to the X-ray.

THE DOEHN CARBON CONSUMING CELL.

A new proposal for making a galvanic cell consuming carbon was made by Dr. A. Coehn, in a communication to the Elektrotechnischer Verein of Berlin, on February 25th. The "Elektrotechnische Zeitscrift" for March 12th makes the following remarks on the subject: "The investigation is based upon a fact which has been already observed by several other electrochemists, but which has so far been found very inconvenient in electrolytical processes in which insoluble anodes are required. The carbons mostly employed have not, under the influence of the current in different liquids, shown sufficient resistance to disintegration. On the contrary, the carbons fell to pieces. In proceeding step by step and with experiments well arranged, Dr. Coehn has been able to find out the exact conditions required to enable the carbon to produce on oxidation only carbon dioxide (CO_2) and carbon monoxide (CO) on the anode. It was found that a certain temperature and a certain current density were necessary conditions, as electrolytic diluted sulphuric acid of a certain gravity was used. Dr. Coehn was further successful in depositing on the cathode the carbon given off by the anode. This proves that the carbon or a compound of it plays an important part in the transport of the electricity through this liquid. To construct a cell which is based on the combination of carbon the necessary oxygen must be supplied to the cathode. This is done by employing peroxide of lead cathode. In such a carbon cell, with dilute sulphuric acid, the carbon burns to monoxide and dioxide, while on the cathode peroxide of lead is reduced to metallic lead."

ARE ROENTGEN RAY PHENOMENA DUE TO SOUND WAVES?

BY PROF. WM. A. ANTHONY.

THE observations of Mr. Edison, recorded in his article in The Electrical Engineer of April 8, do not appear to me to warrant the conclusion at which he arrives. It is well known that sound shadows are not as sharply defined as light shadows and the reason is that the wave lengths of sound are very great compared to those of light. The shorter the wave lengths the sharper should be the shadows; that is, the less should the geometrical shadow be encroached upon by the radiant energy. Now the geometrical shadows for apparatus arranged as in Edison's Fig. 1 would be included between the lines a a′. Rays deflected into the shadow, as shown in that figure, could not have been due to a true difraction, but must have been due to some other cause.

The experiments of Le Conte, to which Mr. Edison refers, so far from warranting the conclusion that Edison draws from his own experiment seem to me to show that Edison's result could not be due to diffraction, and therefore has no bearing upon the question as to the nature of the Röntgen radiations. Le Conte's experiments show comparatively sharp sound shadows. Even at a distance of twelve feet from the pile, only one foot in diameter, casting the shadow, there was no apparent penetration within the geometrical boundary. If any such effect as Edison shows had occurred, the shadows should have been completely obliterated at one foot behind the pile.

The beautiful experiments of Professor Stine and of Scribner and M'Berty indicate a straight line propagation of the Röntgen radiations, and go far to prove that the result obtained by Edison must have been due to some other cause than that to which he ascribes it. These experiments were admirably adapted to demonstrate th source of the Röntgen rays, and led us back to the conclusion originally announced by Röntgen himself, which has always seemed to me to be the true one, notwithstanding all the different conclusions that have been drawn from later experiments. These results go to show how carefully Röntgen had studied the phenomena before making his original announcement.

These experiments seem to demonstrate conclusively that the source of the Röntgen radiations is the bombarded surface of the glass. It is probable, as suggested by Professor Elihu Thomson, that this bombardment produces two effects, one the Röntgen radiations and the other phosphorescence of glass, and that the greater the phosphorescence, the less the Röntgen rays.

I have always wondered why some of the various experimenters upon these phenomena have not made experiments to demonstrate, first, whether the Röntgen radiations are propagated as waves, or are flying particles shot off from the source, and, second, if waves, what is the wave length? If they are wave motions, whether the vibrations are longitudinal or transverse, the fact should be capable of demonstration by diffraction phenomena. Professor Snow, of the Wisconsin University, has suggested a method by which the test could be made.

A parallel beam of rays might be obtained by allowing the vibrations to pass successively through two narrow slits in lead screens placed a little distance apart. This beam being received upon a grating consisting of finer copper wires laid parallel to each other, should, if the radiations are wave motions, give diffraction phenomena that would demonstrate the fact, and also furnish data for computing the wave length, if the radiations consist of a few definite wave lengths only. The question whether those radiations are wave motions or an actual translation of particles, seems to me the most important one to be settled at this stage of the investigation, and I hope some one will take the matter up.

PROPOSED MUNICIPAL PLANT FOR UTICA, N. Y.

Professor E. P. Roberts has estimated $114,000 as the cost of a municipal plant for Utica, to furnish 500 arc lights. Mr. M. H. Johnson, a local electrical engineer, has estimated $161,441. The assumed operating expenses are respectively $39,930 and $44,996.

"We desire to compliment you on the excellent number of The Electrical Engineer which we had occasion to examine in connection with our article on Edison's Experimental Researches on the Röntgen rays."—Houston & Kennelly.

CANDLE POWER OF THE X-RAYS.

BY EDWARD P. THOMPSON.

I USED the following method in order to obtain a rough idea as to the strength of the Röntgen rays as compared with those of a canule. The process, of course, will not give the true candle-power, for the simple reason that the X-rays are not visible, but nevertheless, what may be termed the equivalent of the candle-power may be measured, so that the result impresses one with the extreme weakness of the rays in one sense, although they have so great a penetrating power.

In order to obtain the best results roughly, I receded from the Crookes' tube while looking into the skiascope, until the luminosity disappeared, and then measured the distance between the screen and the Crookes tube. It was about six feet. This represents about the usual power of X-rays, except in Tesla's results where he obtains fluorescence of calcic tungstate at 40 feet. Of course, the luminous rays of the Crookes tube were extinguished by the double thickness of black paper between it and the fluorescent screen.

I then held the skiascope (the name suggested by Prof. Magie, and which I think is by far the best) so as to face the candle, and I walked away from the same until the luminosity of the screen disappeared. The distance was likewise measured. In this case there should be no opaque substance between the candle and the screen. When it is between the Crookes tube and the screen, it has practically no effect upon the X-rays, whereas it would cut off all the rays from the candle. The distance in the latter case was about 120 feet. If the power of X-rays varies inversely as the square of the distance, a candle is 400 times more powerful in producing fluorescence than the X-rays, particularly from a Crookes tube that I employed and charged with the particular apparatus. In the same manner the candle-power of the X-rays from any Crookes tube could be measured.

It is assumed that the fluorescent screen represented the total energy for producing fluorescence as far as the X-rays were concerned. However, the candle rays are not all converted into fluorescent light; for those below the green, including yellow, orange, red and infra-red rays, produce no luminosity upon the fluorescent screen; therefore this method does not compare all the energy of the X-rays with the energy of the candle rays, but it serves to give a rough comparison. It is assumed that the fluorescent screen converted all the ultra-violet rays, violet, indigo, blue and green rays into luminous rays. This assumption may cause unknown errors in the result.

Neither would a corresponding photographic method be exact, because the silver compound would not be chemically acted upon by the infra-red rays. It should be noticed also that both methods are based upon the assumption that all the rays in both cases are converted into green rays of light by means of the fluorescent screen and into chemical energy by the photographic plate.

It remains a fact, however, that as far as we are able to transform the energies, the X-rays are weak as compared with those from the candle. Both will produce fluorescence and chemical action, but the candle very much more powerfully than the X-rays. When the two sets of rays are compared on other grounds, the Röntgen rays are more powerful, as, for for example, in reducing the sparking distance either for a positively or negatively charged insulated plate. Again, from another point of view, the candle rays can be turned out of their course by reflection or refraction. It still remains true, however, in the rough, that inasmuch as fluorescence and chemical action are both produced by the two forms of energy, therefore, these phenomena serve as a standard upon which to operate in order to obtain what may properly be called candle-power, with the restriction that it is not the true candle-power, because things of exactly the same nature are not compared. In the case of the candle-power of the sun, arc light, oxy-hydrogen flame, the incandescent lamp, gas flame, etc., their natures are the same as that of the candle, namely, all have all the luminous rays of the spectrum, but some more than others, so that in these cases we are comparing the rays of similar natures.

THE PHOTOGRAPHIC TIMES for April is as usual interesting to photographers in its reading matter and illustrations. It contains some further illustrations of cathodographs and quotes The Electrical Engineer's announcement of the discovery of J. G. Vine. This magazine has been including in its pages since January an "Encyclopaedic Dictionary of Photography," of value to photographers, and the announcement is made that by the end of this month back numbers of the "Times" containing this dictionary cannot be supplied to intending subscribers.

IS A GLOWWORM RESPONSIVE TO ROENTGEN RAYS?

BY WILLIAM MAVER, JR.

IT has long been a saying among scientists that if the secret of the glow-worm were known we should have at once the most economical of all methods of illumination. I am going to hazard the proposition that Röntgen has, perhaps, discovered it. But, of course, in order to bear out the proposition we must assume that the glow-worm has in its body the necessary fluorescent substance, and that it either possesses the mechanism within its own frame for establishing the X-rays, or two other things must or may be: (a) The X-rays are constantly present everywhere but in a very attenuated form, so to speak, and (b) the fluorescing material in the glow-worm is so exceedingly sensitive to the rays that it responds to them, attenuated as they may be. The glow-worm, it appears, has the power of producing luminescence at will. If this is so, then, taking into consideration the fact that the luminosity of phosphorescent animals is known to remain after the animal is dead, it would appear that the hypothesis that the phosphorescence is due to a material exceedingly sensitive to the assumed, ever present, but very attenuated X-rays, is the correct one, rather than that the glow-worm and other phosphorescent animals have the power within themselves to set up X-rays. The fact that the glow-worm has the power to produce the fluorescence at will may be accounted for by assuming that it has the power to change the chemical form of the fluorescing material at will. I have in mind, in advancing the hypothesis, that the phosphorescing substance of, so called, phosphorescent animals is extremely sensitive to X-rays, an analogous effect, for instance, to that of the sensitive ear of some animals which can detect sound waves that are inaudible to the human ear.

It may be that all of the foregoing may be unsound, and it may be that it is already trite. But as to the latter, in view of the fact that I am a conscientious reader of the electrical press, I feel justified in doubting it.

EXHAUST STEAM HEATING FROM CENTRAL STATIONS

BY I. H. BABCOCK.

LIGHTING and power stations with extensive boiler capacity have brought in new conditions to deal with. Electric lighting companies are competitors with the gas companies, with their well-established business principles of saving and turning all waste products into money. Is it not reasonable to believe that the electric companies will have to pursue the same policy if they are to succeed? At present, where they have not adopted exhaust steam-heating, an electric station is blowing nearly nine-tenths of its fuel through the exhaust pipe. How to save this and convert it into money is the important problem to solve. Some companies have already arrived at a solution by laying underground steam mains and selling steam for heat to the same customers to whom they supply light. They find that all station expenses, that is, their entire fuel bill, their water rents and labor account in the boiler house can be paid entirely from the sale of exhaust steam, so tnat the electric current can be put on the wires free from cost. This gives continuous service for boilers and men, instead of their lying idle a large share of the twenty-four hours. Will this not help out many of the electric companies that are having a hard row to hoe?

Some station managers fear the effect of back pressure upon their engines; this fear is practically groundless. One railway and lighting company that I have in mind is heating over 10,000,000 cubic feet of space with exhaust steam. In the coldest weather the back pressure is not over 3 or 4 pounds, and ordinarily not more than one pound. Their engineer says the engines work with more satisfaction against moderate back pressure than when there is none. With proper sizes of mains for the work to be done, and steam delivered free from entrained water, there will be no difficulty on account of back pressure on engines. The vacuum principle is in force in every building taking steam; the radiators are condensers and as the steam gives off its heat and is converted into water, fresh steam rushes in to supply the threatened vacuum through the service pipes from the mains, so that very little forcing is required if only the pipes are of proper capacity.

If this subject were thoroughly understood by projectors of electric enterprises, whether for railway or lighting purposes, stations would be located with a view to supplying heat as well as light and transportation to customers, from the very start. Happily it is not difficult now for existing plants, in most cases, to make this addition to their present business, and where this has been done, the heating part of the enterprise is looked upon as of equal importance with the primary object.

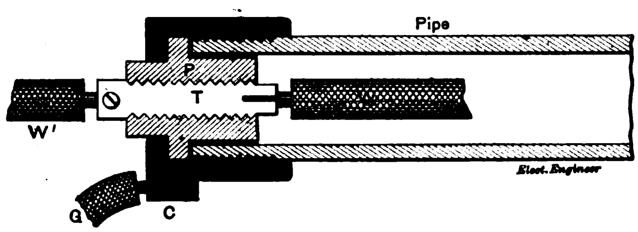
CONCENTRIC WIRING.

BY A. E. DOBBS.

In my last article on the subject of plain iron pipe for conduit, my object was to show how a plain iron pipe could be substituted for the present iron armored conduit. This is as much of a concession as we can expect from the National Board of Fire Underwriters at the present time.

Now for the future I propose a concentric wiring system which may some day become practicable, though many electrical experts will no doubt disagree with me, and the object in view is not so much to suggest brilliant or original ideas as to formulate practical, working details of such a system.

Many of us who have been in the business for years do not feel satisfied with wiring methods now in use. The Interior Conduit people have shown us a great deal of what may be, but still we are not satisfied. Details of construction have not received the care, attention and thought that is given to dynamo and motor design, due possibly to the fact that if a machine is not correctly built there will be trouble right away, while wires can be strung in a building in almost any manner and make no trouble for years, and when they do, the building is simply rewired, or electricity abandoned. Some of us think that wiring methods could be greatly simplified by the use of plain iron pipe with a single wire drawn into it, as suggested by the recent interesting article by Mr. Mavor which appeared recently in "The Electrical Engineer." We find, first, that Mr. C. J. Kintner holds a patent on this method of wiring, but without regard to anybody's patents we can work out a system of details and leave patent questions to be settled in some other way, hoping to suggest a method that will



OUTLET FOR CONCENTRIC WIRING SYSTEM.

meet the approval of the insurance interests, if anybody should wish to install such a system.

On the other side of the water we find the Phoenix (English) rules on this subject as follows:

Concentric Conductors, No. 25.—"Concentric conductors will be allowed under those circumstances and in those places for which permission has first been obtained and when the particular system and design proposed has previously been approved. All joints and connections must be so made that freedom from undue heating would be absolutely secured, and the outer conductor must be so securely protected that all danger from injury, corrosion, or other causes (electrical or otherwise) would be effectually prevented; the precautions taken must be such that it would be impossible for the conductors to be affected by moisture. The whole of the work must be done to the satisfaction of the technical officer of the fire office."

Foot notes accompanying this rule are as follows:

"The insulation resistance between the internal wire and the return of a concentric conductor before being placed up should not be less than 250 megohms per mile; the electromotive force of the current not exceeding 210 volts.

"The internal wire should be positive if possible. It must be insulated to the satisfaction of the technical officer of the fire office in accordance with Rule 4. The insulation must be impervious to moisture and of approved thickness. This insulation should have two approved metallic envelopes, the first one forming the return conductor, the second one forming the 'guard;' these, except when the system is earthed, must be insulated from each other. The 'guard' must be an absolutely efficient protection against mechanical injury taking place to the return conductor, and also an efficient protection against any accession of moisture to the insulation, especially where the system is earthed.

"The carrying capacity of the conductors must be at least equal to the ratio of that laid down for copper in Rule 2; if, however, a metal other than copper be used, the specific resistance of which is greater than that of copper, then the sectional areas of the conductors must be proportionally increased.

"No metal, however, will be allowed to be used for the conductors that does not meet the approval of the technical officer of the fire office; the thickness, also, of the metallic envelopes forming the return and the 'guard' must be to his satisfaction. * * *

"If the system be earthed, then the earthing must be done to the satisfaction of the technical officer of the fire office, but no earth connection will be allowed to a gas pipe, lead or composition pipes. If any part of a concentric system be earthed, then the whole system must be concentric, unless permission to the contrary be given.

"Switches and cut-outs should always act on the internal (or live wire) when the system is earthed."

There are some absurdities in the above rules, to an American at least. First, what is the use of concentric conductors if the outer conductor must be insulated? However, they modify this in a later clause concerning the earthing of the whole system, but leave the whole matter to the discretion of the fire officer, who, it is to be presumed, is more intelligent than a certain inspector I know who required all brass-armored conduit on a brick wall to be cased in wooden boxing, for did not the rules say an "insulated conduit"? The system I have in mind is an iron pipe, which is run on the loop system to outlets and junction boxes the same as any other conduit system. The joints are united by couplings through some metallic compound, or it might be the plastic material which has been so successful in the bonding of railroad tracks so that the resistance of the couplings would be practically negligible; 1,000 feet of one-quarter-inch gas pipe would have a resistance of about 1 ohm, which would surely not be objectionable, as it would be a very exceptional case where such small pipe would have to go further than 200 feet. A ⅜-inch pipe would reduce the resistance of the outer conductor to .7 ohm per thousand feet, which would be still more desirable. This is on the assumption that the material already spoken of makes the resistance of the joints very low. Close-fitting brass couplings might also help us out in this matter and perhaps a set screw in the coupling would be desirable. All this is ordinary gas pipe into which a No. 12 or 14 wire has been drawn, the pipe itself being grounded.

In Fig. 1 is shown a method of bringing the wire out of and into the pipe at fixtures and junctions; T is a lug into which the wire, W, in the pipe soldered; this screws into a porcelain bushing, P, which projects through and is held in place by a cap, C, through which the porcelain bushing projects. The lug, T, may then be connected to the fixture wire, either by a screw or solder.

In combination fixtures the wires, W and G, could be taken down through the fixture, which, of course, could not be connected to the wiring conduit, but in simple electric fixtures a reducing nipple would take the place of the cap, C, and the wire, W', carried right down through the fixture, while the extra wire, G, would not be needed.

On such a system the pipe would be well grounded and all switches and cut-outs would be single pole—another great saving.

Another plan I have sometimes thought of is to have the pipe insulated on the inside, and to pull in bare wire, adopt wire of a certain size as the standard, say, No. 15 B. & S. One of these wires would carry 9 amperes, the limit usually run on a single branch circuit. Two of these wires would be equal to No. 12 single wire, three to No. 10, five to No. 8, and so on down. This would oblige the contractor to carry only one size of wire in stock, the No. 15 bare copper, from which he could make up any desired size of conductor; but, as Mr. Mavor has pointed out, the size of the internal conductors need not be so large, as the resistance of the pipe would be very law.

The objection to this plan would be that in case of a short circuit nothing but covered wire could ever be pulled in afterward; another trouble would be to get an insulation for the inside of the pipe. Paper tubing absorbs moisture; Vulca tubing is brittle, and rubber decays. Porcelain, if made in short lengths and fitted into the tube, might do, but we fear that it would be expensive, and it would allow of but very little pipe bending, but it would prevent short circuits. If any one should invent a flexible glass tubing which was talked of five years ago the whole conduit problem would be easily solved. If any one wants to try this system there is only one way to do; that is, to lay out the entire system in this manner, whether an isolated plant or a town. I do not think a mixed system would answer. It certainly would not do in cities like New York on account of electrolysis; but where the entire system, as in the Edison system, has a grounded neutral which should carry current to the farthest end with not more than 5 per cent loss, such a system should be successful. Of course the insurance people would have to be consulted as to every detail of this plan.

THE ELECTRIC LIGHTING OF ISLINGTON, LONDON.

The Buildings and Plant.—The chief motives which governed the architect (Mr. A. Hessell Tiltman, F. R. I. B. A., who had previously carried out important work for the Vestry, including the splendid baths and wash houses), in conjunction with the electrical engineer, in planning the buildings may be briefly stated as follows: 1. Considerable provision for future extension of the engine and boiler houses at a minimum cost. 2. A full complement of offices, stores, workshops, etc., to meet all future requirements. 3. Special facilities for the delivery and handling of the coal with a minimum of labor. 4. A system of gangways and railway that should govern the easy delivery and removal of heavy goods to and from all parts of the establishment. 5. The separation of the public offices from the engineering department. 6. Light, lofty, and well ventilated rooms, for the health, convenience and comfort of the staff. 7. Mode of finish both internally and externally that should assist the economy of administration by the avoidance of the necessity for periodical repair.

Main Entrance.—The principal and public entrance is situated at the corner of Eden Grove and Grove street. The front elevation is of salt-glazed brick, and is surmounted with a cupola.

A door leads into the timekeeper's office from the street direct, and also forms a private entrance into the works.

The entrance hall, which is faced with cream glazed brick, is shut off from the street by means of ornamental collapsible gates, and from the works by large wood doors. On the left of the entrance hall is a door communicating with a stone staircase which leads to the offices above. At the top of the staircase on the right is the public waiting room, adjoining the public office. Behind the waiting room and through a private door is a corridor leading to the drawing office and the chief engineer's private office. (See plan, Fig. 1.)

On leaving the waiting room, and passing through the swing doors on the right will be found a corridor leading to the assistant engineer's office and the clerks' lavatories. Here another pair of swing doors separates the commercial and the technical departments. Past the swing doors is the photometer room, which is equipped with a photometer and other apparatus (by Messrs. Elliott Bros.) for testing the candle-power, durability, and efficiency of various lamps.

At the end of the corridor on the right is the testing room, which contains a fine set of apparatus for making insulation, copper resistance, and capacity tests, and is used for testing the street mains as well as the alternators, transformers, and other apparatus. Kilowatt and deka-ampere balances, and other standardizing instruments are also provided, as well as a full complement of instruments, resistances, etc., for meter testing and other purposes.

A steel trap in the floor and a girder above permit of converters or other apparatus being hauled from the trucks or wagons below up into the testing room.

Adjoining the testing room is the arc lamp room, where all arc lamps are tested and regulated before being erected in the streets. In this room also is provided a trap in the floor and girder for unloading goods.

Next to this room are the oil stores, containing the oil tanks for engine, dynamo, and cylinder oil. These are of sufficient capacity to hold 1,000 gallons, 1,000 gallons, and 500 gallons, respectively. Directly below the oil stores, in the gangway, is a Worthington pump, by means of which the oil is pumped direct from the barrels in the trucks or wagons up into the tanks without unloading the barrels, after which the empties are returned in the same truck, a considerable saving in labor being thus effected.

Beyond the oil stores is an open area required by the building act. The door on the opposite side of the bridge, and directly facing it, leads to the back of the switchboard, while that on the right leads to the switchroom. This is an exceptionally fine room for the purpose, it being forty feet long, twelve feet wide, and twelve feet high. The floor is covered entirely with rubber mats, for the protection of the attendants and for cleanliness. The room directly overlooks the engine house, of which it forms a part, and communicates with it by means of a balcony and two iron staircases.

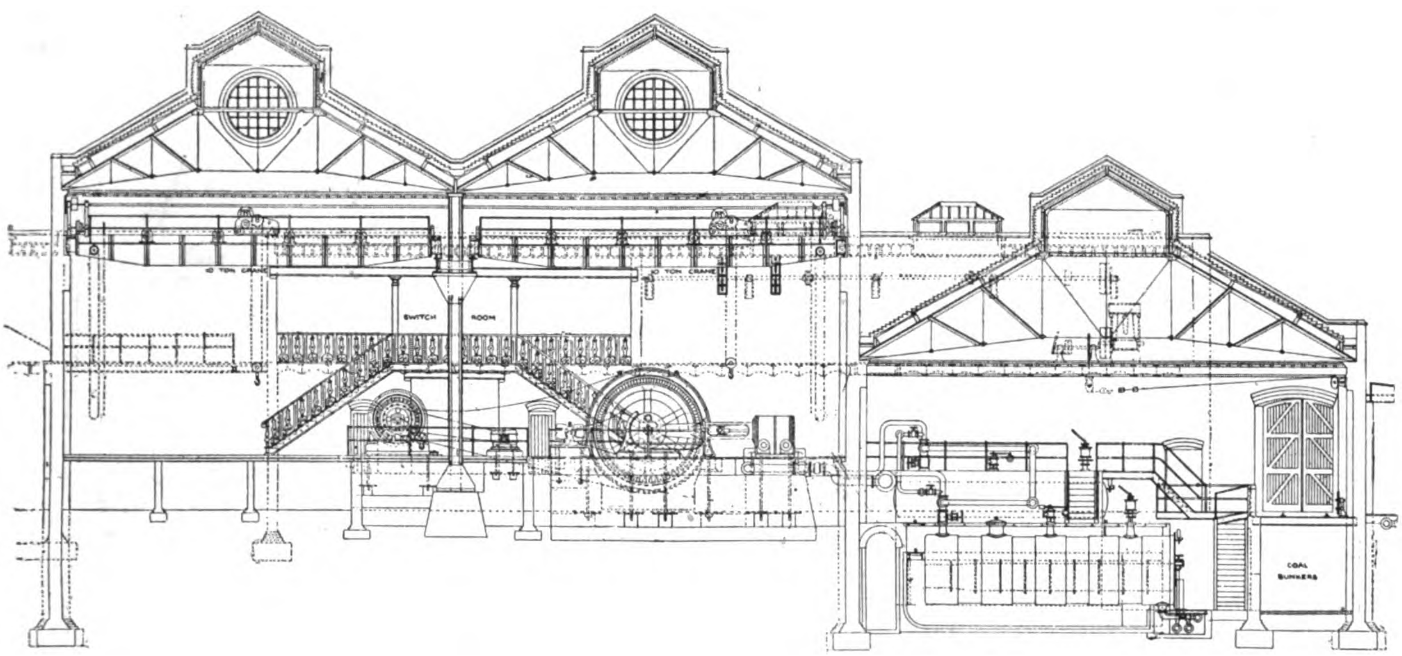


FIG. 1.—ISLINGTON ELECTRIC LIGHT STATION. SECTIONAL VIEW.

The ship's telegraph which stands on the balcony is used for signalling to the engine drivers, it being connected with a large dial fixed on the wall of the engine room directly facing the engines.

From the workshop a flight of stone steps leads down to the gangway. In this gangway, and almost underneath the steps, is a recording weighbridge by Messrs. Avery & Co. This is used for weighing the trucks of coal before they are unloaded into the coal-bunkers. A little farther on the right is an iron door leading to the boiler house. This is a fine building 109 feet in length, 56 feet in width, and 49 feet in height. For the sake of cleanliness and light, the walls (except for the temporary end wall and the interior of the coal-bunkers) are faced throughout with ivory glazed brick.

The ground has been excavated to a depth of eleven feet below the railway level. Large doors communicate with the Great Northern Railway, a private siding being brought right up to the turntable which is situated close to the doors on the outside. From the turntable a railway extends the full length of the boiler house and directly above the coal-bunkers. The loaded coal trucks are hauled into position over the bunkers by means of the traveling winch, which is driven by endless ropes from the engine in the fitting shop. Here the trucks are up-ended by means of the winch, and the coal shot directly into the bunkers below and close to the furnaces, thus saving the heavy charges for labor consequent upon the ordinary methods of delivering and unloading.

From the far end of the boiler house springs a large chimney shaft, which rises to a height of 180 feet. Its internal diameter at the base is 14 feet by 14 feet, and at the top 12 feet by 12 feet; externally it is 24 feet diameter at the bottom and 14 feet 3 inches at the top. It is capable of carrying off

the gases from sixteen boilers similar to those already fixed. The foundation of the shaft consists of a block of Portland cement concrete 9 feet thick and 40 feet square. It may be here mentioned, as a proof of the excellence of the work, material, and design, that not the smallest settlement has occurred.

At the present time the boiler house contains six boilers, each capable of evaporating 5,000 lbs. of water per hour with natural draught. The two water-tube boilers by Messrs. Babcock & Wilcox, Ltd., for quick steaming, are provided in order to meet sudden demands during foggy weather. They are constructed for a pressure of 150 lbs. per square inch, are of mild steel throughout, and possess all the latest improvements—including a slight alteration in design which enables the interior of the outside vertical tubes to be properly inspected; and instead of the "headers" being of cast iron, they are of pressed mild steel, and so arranged that any tube can be readily withdrawn.

The value of these improvements can only be properly appreciated by those who have had experience of the earlier types. A full set of fittings and duplicate feed-water valves and pipes are attached to each boiler.

The four Lancashire boilers by Messrs. Daniel Adamson & Co. are of the latest type and of first-class workmanship.

They are each 28 feet long by 7 feet and 6 inches in diameter, and suitable for a working pressure of 150 lbs. per square inch.

The fittings on all six boilers are by Messrs. J. Hopkinson & Co., Ltd., while Meldrum's furnaces and forced draught apparatus are attached to each boiler. The damper gear, which is of a special character, consists of horizontal steel shafts and mitre wheels connected direct to the dampers. A locking lever and indicator on either side of each boiler enables the stoker to see at a glance the exact position of each damper. This apparatus, which was supplied by Messrs. Adamson, is a great improvement upon the old-fashioned chain and balance weight.

The side walls of each boiler are separated from those of its neighbor by an air space of three inches, so that when any boiler is being cleaned it may be cooled down sufficiently to be handled without discomfort.

In order to prevent any boiler from "lagging" and so throwing extra work upon its neighbors, an isolating valve is attached to the main valve of each. Should the pressure in any boiler fall below that of the range, the valve closes and the steam gauge indicates a lower pressure.

Isolating or back-pressure valves are also attached to the blow-off valves, thus preventing "live" steam being admitted into a boiler when off for cleaning, a necessary precaution for the safety of the men working inside.

Steam Pipes.—The arrangement of steam pipes, which was designed by the electrical engineer, provides all the advantages of a steam ring, and at the same time avoids many of its disadvantages. Each engine is connected direct to the main valve of a boiler, and also to an auxiliary or equalizing pipe through a second valve. When all valves are open and the engines and boilers connected to them are in operation, no steam passes through the auxiliary pipe, provided the engines are all equally loaded, each engine being supplied by its own boiler. If the engines are unequally loaded, steam will pass along the pipe from the boilers connected to the "light" engines and assist the boilers connected to the "loaded" engines. Should the boiler connected to any engine be shut down for cleaning or any other purpose, steam to that engine will be supplied from all the other boilers along the auxiliary pipe.

The chief advantages of this arrangement over the "ring" main are:

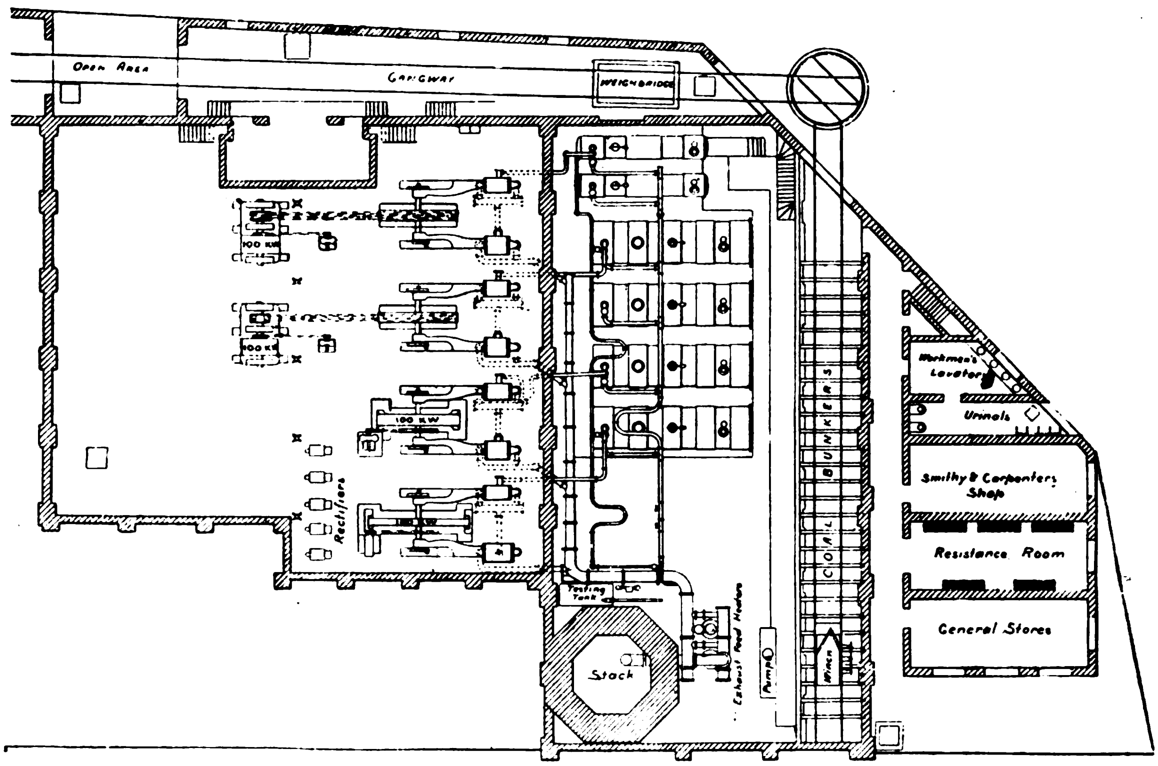


Fig. 2.—Islington Electric Light Station. Plan View.

(1) Much less pipe required and much smaller in diameter, and therefore less radiation, and fewer joints and valves; (2) Much less risk of fracture, or of leaky joints, with small pipes; (3) On light loads the range can, if advisable, be shut off entirely and the engine supplied direct from its boiler, thus saving all radiation except that due to the short connecting pipe and the engine and boiler; (4) In the event of accident to the pipes, they can be shut off, and each engine can then be supplied from a separate boiler.

All the valves are provided with "by-passes" for warming the pipes slowly. A door over the coal-bunkers leads to the messroom, where the workmen can cook their food, all appliances for the purpose being supplied. Tables, chairs, lockers, etc., are also provided for their convenience. Below the messroom is the changing room and lavatories, and adjoining are the general stores, smithy, etc. Above the stores and smithy are two large water tanks for supplying the boilers. Each tank is capable of holding 21,000 gallons. Separate supply pipes are carried to the boiler house, and they are so arranged that either tank can supply either pipe or both.

On returning through the boiler house and entering the gangway, a projecting platform will be seen which is reached by two short flights of stone steps. This platform projects from the engine house, from which it is separated by means of a steel rolling shutter. Trucks containing machinery or other plant intended for the engine room are unloaded here. Beyond the iron shutter is the engine house, a very fine building 88 feet wide, 80 feet long, and 47 feet high from the floor level.

The roof, which is arranged in the form of a double gable, is supported in the center by five steel stanchions, each capable of bearing a safe load of 75 tons. All the walls, with the exception of the temporary walls (at the end), are faced with ivory glazed brick, ornamented with red salt-glazed bricks, a dado of the latter running around behind the engines and along the walls adjoining. Two heavy traveling cranes span the building, each capable of lifting and carrying ten tons. They are driven by means of endless ropes from the engine in the fitters' shop, but they can also be used as hand cranes if required. The motion is given by means of worm-gearing, thus preventing the possibility of the load slipping, the "lowering" having to be effected by the gear instead of by a brake, which is a fruitful source of accident.

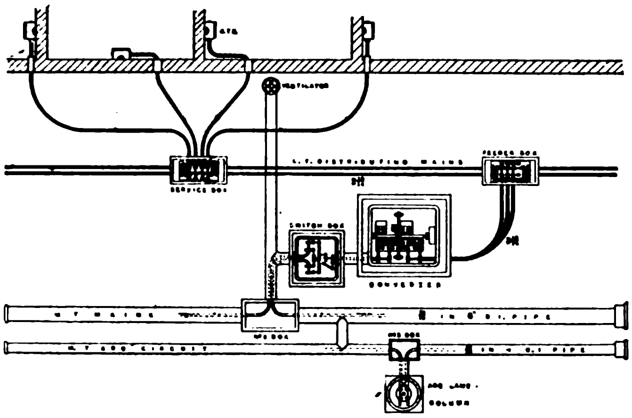


FIG. 3.—CONNECTIONS OF MAINS, CONVERTERS, ETC.

The engines, of which there are four (by Messrs. Daniel Adamson & Co.), are of the horizontal, high-pressure, compound, non-condensing type, with cylinders arranged side by side, the high-pressure cylinder being 15 inches in diameter, and the low-pressure 24 inches; the stroke is three feet. The engines run at 95 revolutions per minute, thus giving a piston speed of 570 feet per minute. Both the cylinders are steam jacketed with high-pressure steam direct from the boilers, the jackets being coupled with suitable valves and connections to an automatic steam trap. The engines will indicate 250 horsepower each at a pressure of 150 lbs. at the cylinder.

Two of the engines are rope driving, the flywheels being 14 feet diameter, and grooved on the rim for ten ropes each of 1¼ inches diameter. The other two engines drive the alternators direct on the shaft.

The Alternators.—There are four alternators, each having a safe working capacity of 125 kilowatts at a pressure of 2,000 volts, the frequency being fifty complete periods per second.

Three of the machines, viz., one direct-driven and two rope-driven, are of the "Hall" type, and were made by Messrs. John Fowler & Co.; the fourth is a direct-driven machine by Messrs. Ferranti. The rope-driven machines run at a speed of 375 revolutions per minute, the field magnets (which are laminated) forming the rotating part. The armature core is built up in sections, each section with the coil attached being removable without dismantling the other parts of the machine.

The guaranteed commercial efficiency of the alternators is 92 per cent. The Fowler direct-driven alternator is similar in type, the magnets being laminated and mounted on the flywheel of the engine. The diameter of the magnet flywheel is about 12 feet, the overall diameter of the armature casting being 14 feet.

Ferranti Alternator.—The Ferranti alternator is of the same type as those erected by Messrs. S. Z. de Ferranti at Portsmouth and Southport, where they have given great satisfaction.

Rectifiers.—There are five rectifiers, Fig. 4, used for the purpose of supplying the street lamps. These were made by Messrs. S. Z. de Ferranti & Co., and their duty is to transform the alternating current into a pulsating current continuous in direction. Four rectifiers are in use, a fifth being held in reserve.

Each rectifier is complete with constant current transformer, switch gear, etc., and is capable of supplying thirty arc lamps of twelve amperes each, or a total of 120 lamps exclusive of the reserve plant.

Similar rectifiers are successfully doing public lighting at Portsmouth, Tunbridge Wells, Cardiff, and other places.

The present engine house is capable of accommodating seven engines similar to those now fixed; and by removing the temporary walls at the end and extending the building to the boundary of the Vestry's property at present acquired, further accommodation for nine similar engines can be made. Leaving the engine house, and turning to the left in the main gangway, there will be found two large doors opening on a piece of open ground. This is the site of a future boiler house, similar in size to the existing one. The footings of the walls are thirteen feet below the railway level. All that remains to be done is to excavate the ground and erect the roof and end wall. Eight boilers can then be accommodated here, while provision has been made to duplicate the arrangements now existing in the present boiler house; and, as will be seen, the railway has already been brought to the door and a turntable provided.

Mains.—The high-tension mains consist of concentric steel-armored cable, heavily insulated with pure and vulcanized rubber and protected with braiding. The two layers of steel tape armoring are covered with two layers of heavy braiding and perservative compound. The insulation resistance from core to outer is 5,000 megohms per mile, and from outer to earth 2,500 megohms, tested in water after twenty-four hours' immersion at a temperature of 60° Fahrenheit and after one minute's electrification. The outer conductor is earthed at the switchboard. The cables, which were manufactured by the Indiarubber, Gutta Percha and Telegraph Works Company, Ltd., are drawn through six-inch cast-iron pipes, which are provided with inspection boxes at intervals of about 100 yards. At the corners of every street en route large square boxes are provided for future extensions.

Two "ring" mains have at present been laid along the compulsory area (see Fig. 3), and at intervals switchboxes have been inserted enabling any section to be cut out for testing or other purposes without interfering with the remainder.

Street box transformers are laid where required, and are connected on the high-tension side direct to the mains without joints, sufficient slack being left in the inspection boxes for the purpose. The secondary of each transformer is connected to a low-tension service box which is inserted in the low-tension mains. These low-tension mains are only laid where there are customers, and service boxes are inserted at intervals of about twenty-five yards. From the service boxes the various service lines pass to the consumers' terminals, and any consumer can be disconnected at the service boxes for the purpose of testing, etc.

The low-tension mains and services consist of concentric steel-armored cable insulated with pure and vulcanized rubber and heavily braided both over the rubber and outside the armoring. The insulation resistance is 600 megohms per mile between core and outer, and 300 megohms between outer and earth. The cables are laid direct in the ground.

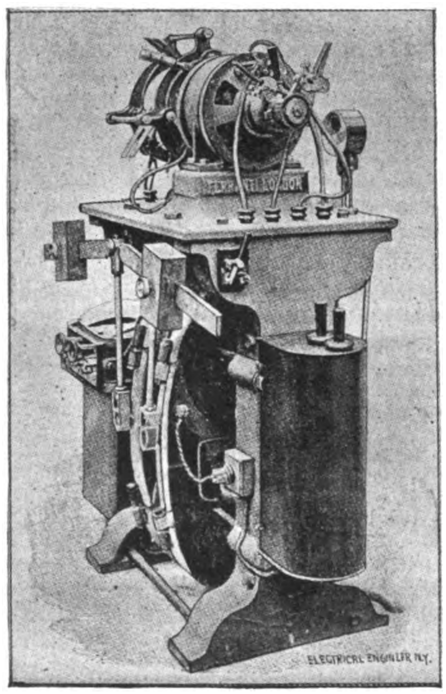


FIG. 4.—THE FERRANTI RECTIFIER.

The arc lighting mains consist of concentric steel-armored cable drawn through four-inch cast-iron pipes. The insulation and quality are the same as that used for the alternating high-tension mains before described. Inspection boxes are laid at

the foot of every lamp column, and the mains are carried up to the switch in each column without joint.

There are at present fourteen miles of cast-iron pipes laid in the district, and both pipes and boxes were supplied by the British Insulated Wire Company.

Transformers.—The transformers, which were supplied by Messrs. S. Z. de Ferranti, Ltd., are placed in suitable positions in the footways in iron boxes or chambers which are sufficiently large for a transformer of any size up to twenty kilowatts, this being the largest size allowed by the Board of Trade under the Vestry's Provisional Order.

Street Lamps.—The street lamps are of the Crompton-Pochin type, by Messrs. Crompton & Co., of Chelmsford, and are mounted on the top of handsome iron columns. The "crutches" carrying the lamps are supported on hinges, so that by releasing a catch the top of the crutch falls forward, where it is held by a chain. This throws the lamp out beyond the lamp column, and enables the globe to be removed for cleaning and trimming.

The lamp columns, which were made by Messrs. Walter Macfarlane & Co., are mounted by means of removable steel steps, which are inserted in holes in the columns provided for the purpose.

Ventilation.—In order to prevent as far as possible the accumulation of gas in the street conduits and boxes, they are connected throughout the district with the hollow lamp columns, while at frequent intervals ventilators on a level with the footpath are connected with the pipe system. It is hoped that this will prevent the accumulation and possible explosion of gas in the conduits which has given so much trouble in some districts.

Method of charging for electric energy.—Current is supplied to private customers through Hookham patent electricity meters, and is charged for on the well-known Brighton system, Wright's demand indicators being used for recording the maximum demand. The scale of charges has been arranged as follows: For the first two hours' consumption per day of the maximum demand the full price will be charged, viz., 7d. per unit; for the third hour's consumption, as above, 6d. per unit; for the third and fourth hours' consumption, 5d. per unit; for any further consumption, 4d. per unit.

We are indebted to several of our London contemporaries for the accompanying engravings.

A GOVERNMENT INQUIRY ON MUNICIPAL LIGHTING PLANTS.

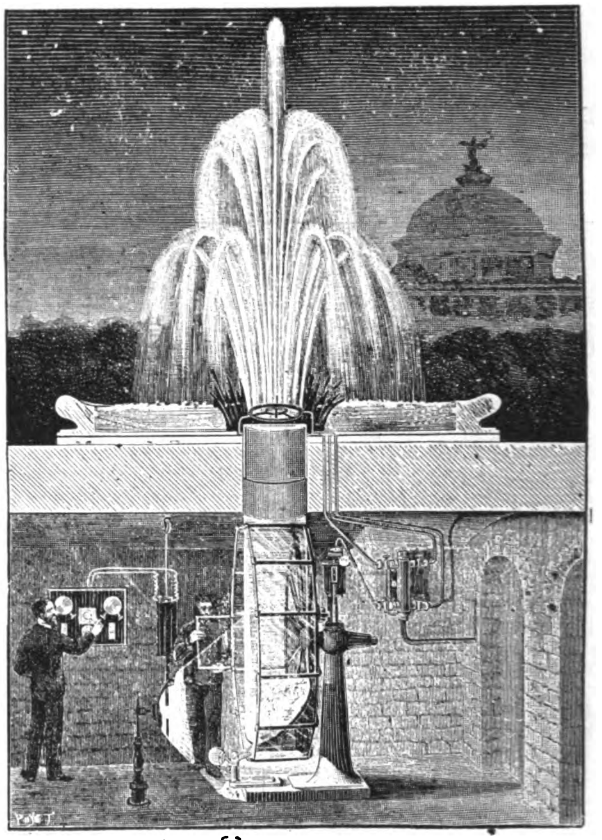
The subject of municipal ownership of gas and electric-light plants is proposed as a subject for joint investigation by the National Department of Labor and the Bureaus of Labor Statistics in the several States, the agents of the National Bureau to confine their inquiries to States which have no bureaus of statistics. The inquiry will be made in all cases upon uniform blanks and according to uniform methods. This will add greatly to the value of results and their convenience for investigators, because it will make it possible to make easy and exact comparisons. Every electric and gas-lighting plant in the United States which is owned by the municipality will be reported upon, and a sufficient number of private establishments will be included to afford a basis of comparison between the two classes. The mere difference in price of lighting is often relied upon in these controversies to decide the merits of the two systems, but many other elements will be considered in the proposed inquiry. Full statistics of the cost of plant, the interest on plant, the cost of materials, the wages paid, the cost of superintendence, and the quality of lighting furnished will be given. The balance sheet for public and private establishments, indicating whether the public establishments pay a real profit, make up a deficiency from taxation, or pay a nominal profit by ignoring the cost of plant and bonded indebtedness incurred for its establishment, will be presented in each case. These results, tabulated according to uniform methods, will be sent to the National Department of Labor, according to the plans of the executive committee, and will there be consolidated into a complete report covering the entire United States. The features of this report will be furnished to the various State bureaus for use in their own reports, with such additional detail as they may think it desirable to furnish for local uses.

MR. W. F. BROWN, of Auburn, Me., has been made superintendent of the Bellows Falls Electric Light and Power system, which is owned by the Fall Mountain Paper Co., of Vermont.

THE ADAMOFF LUMINOUS FOUNTAIN.

An innovation in the operation of electric fountains has recently been introduced by M. A. Adamoff, a well-known manufacturer, of Baku, Russia. In this arrangement there is employed what is called an Adamoff prismatic wheel, consisting of two principal parts, namely, a hydraulic piston motor and a wheel, the whole supported on a cast-iron base. The piston of the motor communicates its motion to a wheel by means of a cam, in which there are successively engaged the steel pins, arranged regularly around the circumference on a solid disc, forming one piece with the wheel. The latter, of prismatic form, with a regular polygonal base, is mounted on a shaft turning on a horizontal bearing. It is arranged so as to receive the frames, in which are placed the colored glass plates, and these frames can be very readily replaced while the wheel is in motion. The wheel is installed in a compartment below the fountain.

The arc light employed is placed in front of a parabolic reflector, which throws the rays upon a plane mirror placed



Adamoff's Luminous Fountain.

within the wheel, which reflects them upward into the fountain, or the lamp can be arranged with a reflector directly within the wheel. By means of a cock and valve the wheel can be turned intermittently, and the periods of rest determined at will.

It will be readily seen that with a dozen or fifteen apparatuses regulated from one central point, the apparatus being all subjected to the pressure from the same water pipe, all the motors can be regulated to the same position, and thus a regular change of colors effected with the combinations determined in advance. It will also be noted that a great variety of combinations can be obtained by giving the motors different speeds.

C. B. ROUSS, the wealthy but blind Broadway "notions" merchant, wants to try the effect of a Tesla current on his optic nerves, and offers a fortune if any good results. Mr. Tesla is willing to administer the current, if the medical adviser approves, but declines the offered money.

THE ELECTRIC SCENIC COMPANY, of New York City, has been formed with a capital stock of $20,000. The directors are G. W. Bithridge, W. S. Munn, W. W. Thomas, T. P. Smith and Benton Murphin, all of New York.

HIGH VOLTAGE LAMPS AND THEIR INFLUENCE IN CENTRAL STATION PRACTICE.—II.

BY G. L. ADDENBROOKE, M. I. E. E.

Concurrently with this development there has been a tendency towards the use of lamps of ordinary voltage, but of higher efficiency, and I must say that until recently I have been unable to quite make up my mind which was the best of the two lines to work on—whether it would be better to use lamps of 100 voltage, and taking 2½ watts per candle-power, or lamps taking four watts per candle-power, with a voltage of 200 or 220. I think, however, the matter now admits of being argued out pretty clearly. By a reduction of current per candle-power, in the proportion of 2½ to 4, mains of a given capacity would do nearly double the amount of lighting with the same expenditure of energy. Energy in itself is very cheap, however, and any fair-sized central station could supply double the quantity of energy it is now doing at 1½d. per unit for the extra current, if this did not entail extra expense for extra mains. Now, by doubling the voltage, we reduce the size of the mains to one-fourth, other things being equal; consequently the mains for a station using 220-volt lamps consuming 64 to 70 watts per 16-c. p. lamp, to give the same percentage loss, would not be much more than half the size they would be if the station supplied 110-volt lamps consuming 2½ watts per candle-power, as the current would be nearly the same in both cases. As the cost of mains is such a very large proportion of the whole central-station cost, and, as energy can be generated so cheaply, I am fairly confident that, even if a good 2½-watt lamp were obtainable, it would pay better to use 220-volt lamps taking nearly double the current. Conversations with lampmakers, and recent publications on the subject have convinced me that a good 2½-watt lamp of 100 volts has yet to be attained, and will probably be a very difficult thing to achieve, unless absolutely even pressures in the mains can be guaranteed. The opinion of lampmakers appears universally to be that a 220-volt lamp at 3½ to 4 watts per candle-power is a more practicable and attainable object than a 100-volt lamp at 2½ watts. They seem also unanimous that if a good 2½-watt 100-volt lamp could be made, a good lamp of 220 volts, and of better efficiency than 4 watts, would be forthcoming. It therefore appears that by taking a 220-volt lamp now we shall get all the advantages of high voltage, and in time shall get nearly as efficient a lamp as if a lower voltage were used, while the high-efficiency lamp is even now in a far less forward state of development than the high-voltage lamp. Consequently, it seems clear that the high-voltage lamp is the better line of the two at present. Besides this, we are anxious to cheapen the cost of current so that it may also be available for power purposes, and thus small economies in consumption will be of less and less moment. It is, therefore, obvious that not only in the present, but for the future, the high-voltage lamp is likely to be the better, and that it is safe to run the risk of being unable to use very economical lamps, provided decent ones of high voltage can be obtained.

As I thought it would give a practical basis to this paper, and would be of interest to members to see specimens of some of the various high-voltage lamps which are being made, I have written to leading makers on the subject, and through their kindness am able to submit a number of 220-volt lamps, concerning which I will now give the particulars supplied by the makers.

Lamps to be arranged to burn; present data from makers, etc.: I shall not pursue this branch of my subject further, as it would be more suitably dealt with by a lamp manufacturer in a special paper; but I think enough has been said, coupled with the knowledge members already have of the subject, to show that high-voltage lamps are thoroughly practical for central-station work, and I therefore pass on to consider how far it is desirable to use them, and what effects they are likely to have on central-station practice—this being more immediately the subject of my paper.

Life of High-Voltage Lamps.—We can, of course, hardly expect the life of these high-voltage lamps to be as long as that of lamps of half the voltage, while at the same time they will be rather more expensive, consequently there will be a greater expenditure for lamp renewals when they are used; and it is advisable, I think, to try and arrive at a figure for this before proceeding further. If the life of an ordinary 16-c. p. lamp of 100 volts is 1,200 hours, and it consumes 64 watts, during its life it will consume 77 B. T. units, which, at 6d. per unit, amounts to 38s. 6d. If the cost of the lamp is 1s. 3d., its cost per unit of current consumed is 0.2d., or 1-5d., or about 3 per cent. of the cost of the current. For an eight-candle lamp of 100 volts, lasting 800 hours and taking 36 watts, the consumption of current is 29 units; and at the same price for lamps, the lamp cost per unit of current consumed is about 0.5d., or ½d., or about 8 per cent. of the cost of the current. I have assumed the above life for these lamps because I think, after burning the number of hours indicated above, most lamps would be best thrown away, though I am perfectly aware lamps often last twice as long as I have assumed, and they can also be purchased for 20 per cent. less from reliable makers. Two hundred-volt or 220-volt lamps will, of course, cost rather more, and their life would be rather less, but I believe I am putting the case more adversely for the higher-voltage lamps than is really true in taking the cost as double the above rates for lamp renewals where high-voltage lamps are used. The cost of lamp renewals would then be 6 per cent. of a customer's bill if the current was 6d. per unit for 16-c. p. lamps, and 16 per cent. if 8-c. p. lamps were used. Supposing the number of 16-c. p. lamps installed to 8-c. lamps is about as 1:2—which is, I think, about a fair average—an all-round reduction of 6 per cent. in the charge per unit of current would cover the additional cost of lamps, if lamps of high voltage were used; at 6d. per unit for current, this is about one-third of a penny per B. T. unit. Such figures as these can only be approximate, but I think you will agree that they would not be far out in practice, and may be improved upon, and also that they make it clearly manifest that the extra cost of using high-voltage lamps offers no appreciable bar to their introduction, providing that their other countervailing advantages are in excess, with which branch of the subject I will now deal.

Effect of Using High-voltage Lamps on Distribution.—On this point I do not think I can do better, as a commencement, than quote from my article in the "Electrical Review" of the 11th of January, 1895:—"How great a gain there is in distributing current at a higher voltage, and how much it simplifies the distributing problem, is not at first sight fully apparent, though everyone recognises that there are advantages. The advantages may really be said to progress as the cube of the voltage, up to, say, about 200 volts. For let us suppose we have a station on all of whose circuits the lamps require 200 volts to incandesce them, instead of the usual 100 volts. In the first place, having doubled the pressure, we may extend our mains double the distance at the same current-density, with the same percentage loss; but at the higher voltage the same current-density in a given sized main will give us twice the energy and light twice the number of lamps. Consequently, without increasing the sectional area of the mains, we can do four times the lighting with the same mains, or the same amount of lighting at four times the distance with the same percentage loss. Then there is a further gain, for, since we can extend the mains four times as far from the central station with the same percentage loss, the area which can be served from a single station is 16 times greater at the higher pressure than at the lower. Presuming, however, that this argument is not pushed to its extreme limits, it is well within the mark to say that at 200 volts nine or ten times the area could be better served on the three-wire system from a single station than is now the case at 100 volts; not only is this the case with the feeders, but it extends in an even greater degree to the distributing system. At present there is no doubt that there is an inconvenient fall of voltage in the distributing mains, and the internal wiring of houses, which leads to irregular and unsatisfactory lighting, and which is under existing circumstances, whatever system is employed, exceedingly difficult to remedy. If by any means the voltage could be increased to 200 volts this would practically vanish, distributing mains might be carried three times their present distance from the feeding point, and the fall of potential in houses would be merely nominal on the present basis of wiring, instead of frequently amounting to 1-2 volts or more. By these means the number of feeding points in a given area would of course be much reduced. The same fittings and wiring as are now used would be applicable, and the voltage does not go beyond the Board of Trade limits."

This was a general statement, made largely with a view to point out to manufacturers what a field it would open if they could produce a commercially satisfactory high-voltage lamp. During the last eighteen months manufacturers have seen the advantage of exploiting this field, with results which have already been detailed above. Consequently it is desirable to look a little more closely at the distribution problem under its new aspect, and I will, therefore, ask your particular attention to the figures which I now propose to lay before you.

THE ELECTRICAL TRADE WITH GERMANY.—Mr. H. Beneke, Flensburg, Germany, late U. S. Consul, informs us that he is now occupied in introducing American manufactures, especially of the electrical kind, into Germany, and that he will be glad to hear from any firms or persons desiring representation.

THE

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CONTENTS.

X-RAY THEORIES.

THE phenomena of the X-ray were well calculated to set the minds of thinkers at work to accommodate the observed facts to a comprehensive theory; but, though the facts are multiplying fast, it can hardly be said that they are yet sufficient to establish anything but hypotheses, and most of these even can only be of a tentative nature. Röntgen himself ascribed the X-ray to longitudinal ether vibrations, though by no means insisting on this view, owing to lack of complete evidence, and Jaumann has fortified this theory mathematically. Lord Kelvin has suggested the condensational wave theory as an explanation, while others have in turn attributed the X-ray to electrolytic and again to electrostatic sources. All these theories or hypotheses involve the ether, or an intermolecular action of some sort, but it remained for Mr. Edison to propose another explanation—the purely mechanical sound wave effect—to account for the observed phenomena. As was to be expected, this theory has not remained unchallenged, as our columns this week will bear witness. Nevertheless, Mr. Edison still maintains his opinion, and sees further confirmation of it in his more recent experiments. Briefly stated, Mr. Edison's theory is that the X-ray of Röntgen is a wave in air and matter, and not a wave in the ether—in other words, a sound wave; that it is not rhythmical, but a number of waves of various amplitudes and sequences. According to this theory these waves enter matter at the surface of the glass and are produced by the percussion of the molecules of gas and particles from the electrodes thrown with great velocity against the glass, and, by its elasticity, sent as a wave into space. The gas molecules, in turn, rebound from the glass with a diminished velocity or an energy minus that absorbed by the heating of the glass and the wave energy sent out into space. In the rebound they strike the glass chamber at another point, giving a second concussion and wave. Thus they probably vibrate back and forth a number of times. Hence the whole of the glass of the chamber gives out waves, but not so strongly as that portion which receives the primary concussion. Further, when the vacuum is too high, the ray is weakened by the number of molecules being insufficient to produce enough waves; on the other hand, when the vacuum is poor there is too much interference, or lessened free paths. There must thus be a critical point where there is the maximum number of molecules with the maximum free paths, and experiment proves this to be the case without any doubt. Mr. Edison is certain that there is a concussive action on the glass due to the cannon ball action of these molecules. The energy of these concussions is sufficient to even melt the glass, and if the X-ray is not due to the elastic action of the glass under concussion, then what, Mr. Edison inquires, becomes of these waves? These, at least, must be sound waves in matter and not in the ether. Their energy is great, their wave lengths are extremely short relative to ordinary sound waves, they should produce sharp shadows and they should perform work away from the tube. If they are not the X-ray, then there is another ray, a sound ray, and it only requires conditions to bring it out with great force. Mr. Edison contends that this concussion wave is the X-ray, and that the action on crystals of various substances causes the absorbed energy to be radiated as light.

We have given Mr. Edison's views somewhat in full here,

as explained to ourselves, so that they may be compared with other theories which have been proposed. Mr. Edison, as we stated last week, is well aware that many physicists will shake their heads at his explanation of the X-ray, but with his characteristic pertinacity he is maintaining it and seeking new facts to sustain it or to break it down.

ELECTRICAL EXPOSITION ACTIVITY.

THE rising tide of activity in matters connected with the National Electrical Exposition makes its mark in our pages this week, and the various items are but a superficial evidence of the work that is being done. It is already apparent that the exposition will be a success, but it was hardly expected that the public and daily press would soon quickly manifest an interest in it. Still that fact should not be surprising, for electricity is the great living center of movement and progress at the close of the nineteenth century, and the community is anxious and willing to learn all it can about its uses, old and new. As we have said before, the management cannot too strongly bring out the educational, novel, and entertaining features of the show, for the public will be drawn by them and the more commercial exhibits will thus in turn derive benefit and themselves attract by intrinsic merit. The National Electric Light Association bids fair to do the electrical science and art lasting good by this effort.

ELECTRIC VS. STEAM LOCOMOTIVES.

ELECTRIC railroading has reached that stage of development where it no longer requires argument as to its applicability to earn dividends on short lines heretofore operated by steam, and we may therefore expect to see more of the old roads equipped that way this spring. This short haul traffic is, however, more or less in the nature of street railway traffic, especially when we consider that some city roads operate lines 25 and 30 miles in length. What the railroad world is still on the lookout for is the solution of the long haul traffic problem by electricity. Steam railway engineers probably still regard the introduction of a general system of trunk lines operated electrically as far in the future, and they have been led to believe so as much by the statements of electrical engineers as by those of their own fraternity. By this we mean that electrical engineers of repute, in their conservatism, have in the past placed limits upon the electrical locomotive which seemed, for the present, at least, to bar it from general trunk line passenger service. It will be remembered that in answer to the question, "Will electricity take the place of steam for railroad purposes?" in his A. I. E. E. inaugural presidential address in 1892, Mr. Frank J. Sprague replied: "Only in part, and then only when the number of units operated between the terminal points is so large that the fuel economy would pay a reasonable interest and depreciation on the necessary cost of central station and the system of conductors." There is no doubt that, broadly, this statement of the case is correct, but thus far no one seems to have investigated to any practical extent the very point upon which the whole question pivots, namely, that of fuel, together with that of other, by no means insignificant items, such as repairs and running attendance. The articles by Mr. William Baxter, Jr., which we are now publishing, have shed a flood of light on this question, and represent probably the first exhaustive treatment of this important question. Mr. Baxter, by analyzing the reports of present steam trunk lines, has developed several striking points, tending to show that electricity is far closer to the point of practical economy under existing traffic conditions than had been suspected, and in this issue he still further strengthens his argument by showing the favorable status of the electric freight locomotive as compared with the steam locomotive. We will not anticipate Mr. Baxter's final conclusions as applied to an actual case, but what has already been shown will be sufficient, we think, to lead railroad men to look seriously to the electrical possibilities with which they may have to deal in the not distant future.

PISTOLS OR ARC LIGHTS?

AT the recent meeting of a Commercial Club in the West, an argument was made in favor of street lighting by electricity that is one of the most convincing we ever saw. It is not new to consider an arc light as equal in efficiency to one policeman, or even equal to two, but we have never observed the matter stated quite so strongly before. One of the members produced an old pistol, flourished it in the eyes of his startled fellows, and then said:

"As I sat reading my evening paper a young woman dashed into our house, breathless and disturbed. When she had caught her breath, she told me that she had been pursued by a negro. I know her to be a truthful person, and I know that on a former occasion in the city where she worked nights she held a highwayman at bay with a pistol, and it seems the villain still pursues her. I got out this pistol, escorted her home, and came up here to suggest that we all keep a lookout for the ruffian who frightened her."

It is needless to add that the club proceeded to vote forthwith in favor of electric lighting. Only one vote was recorded in favor of pistols as a protection to chastity, and that came, it is said, from a "high-toned gentleman," who preferred the older regime of affairs, when life in his section of the country was one long Schuetzenfest.

COMPENSATION OF ELECTRICAL ENGINEERS.

WE are glad to learn that a long since suggested movement has been started in Chicago, the object of which is to establish or maintain a uniform schedule of fees for electrical engineering work and the enforcement of a stringent code of professional ethics. It is proposed that a society shall be organized for this purpose, answering to the societies of architects. It would have seemed at first blush that the American Institute of Electrical Engineers is the best body in the country to take a hand in sustaining professional dignity and honor, but as that society was reluctant even to lend its consultative aid to the establishment of a code of national rules for proper electrical construction, it is obvious that the organization suggested at Chicago has a clear and specific field. It is urged that the fee for independent consulting electrical engineers shall not be less than 5 per cent. for entire charge and supervision of plants, and that they shall do no construction work nor be connected with selling agencies. The movement, on its broad lines, has our heartiest approval, and we trust it will succeed. The electrical engineer cannot too soon be put on the same level as his professional brother—the architect—for he belongs there by virtue of his training, experience and responsibility; and an inflexible professional code applies to his vocation as much as to any other branch in the domain of engineering.

TELEPHONY AND TELEGRAPHY.

ON TELEPHONIC DISTURBANCES CAUSED BY HIGH-VOLTAGE CURRENTS.[1]—I.

BY DR. V. WIETLISBACH,

AFTER a brief summary of the conflict of interests between telephone and power undertakings the author proceeds as follows:—

The injurious disturbances to telephone lines, in so far as they are traceable to the action of the electric current, may be considered under three heads:—

I. The high-voltage current may enter the low-voltage line in consequence of accidental contact with a telephone wire, or in consequence of other accidents, such as the fracture of a pole, support or wire. If the tension of the intrusive current be high, the intensity of the current may become so great as to destroy the telephone apparatus or melt the telephone conductor; or again, the latter may become so overheated as to ignite any wooden parts near it, and thereby set even large telephone stations on fire, such occurrences having already occasioned damage amounting to millions of francs.

II. When the high- or the low-voltage line is either uninsulated, or insufficiently insulated from earth, or when both lines are carried on the same poles or supports, part of the high-tension current may enter the telephone line through earth not only occasionally, i. e., under exceptional circumstances, but permanently. If the high-voltage current be a perfectly constant direct current, such as, e. g., that supplied from a storage battery, no effect is noticeable in the telephone except that the sensitiveness of the apparatus is somewhat impaired when the tension of the high-voltage current exceeds a certain limit. But if the high-voltage current be pulsating, which it always is where continuous current is used for driving car motors; or, again, if the high-voltage current be a single or polyphase alternating current, a humming noise is set up in the telephone apparatus, the humming being less violent in the case of a pulsating direct current, but very violent in the case of an alternating current, so that in either case telephonic communication may be rendered difficult or altogether impossible.

III. The high-voltage current affects low-voltage lines in the neighborhood by induction, i. e., to every rise and fall of the high-voltage current there is a corresponding electric wave in the telephone line, the intensity of that wave being proportional to the oscillation in the high-voltage line current; in other terms, a succession of electric waves in one conductor is faithfully reproduced by a similar succession of waves in the other. There is an essential difference in the effect of electro-magnetic and electrostatic induction. In both cases the electromotive force is proportional to the magnitude of the change in the primary, i. e., the inducing current, and is governed by the reciprocal position of the lines and by the distance over which the two lines run parallel to each other.[2] In the case of electromagnetic induction, the intensity of the induced current set up is inversely proportional to the resistance, i. e., it decreases as the length increases. On the other hand, in the case of electrostatic induction, the intensity of that current is proportional to the capacity of the affected line, and, therefore, also proportional to the length of the latter. Hence electromagnetic induction predominates, generally speaking, in short lines, and electrostatic induction in long lines, independently of the distance over which the two sets of conductors run parallel to each other.

The disturbances considered under I. may be counteracted by lead fuses inserted in the telephone line at the point where the latter enters the building, and which melt when the intrusive high-voltage current exceeds one ampere. By that means the line is interrupted, and damage to the telephone apparatus is rendered impossible. There is no difficulty in constructing safety fuses, which are far more sensitive than those mentioned; but they offer no practical advantage, because they melt much too easily even in the case of very light thunderstorms, and hence only produce innumerable interruptions which greatly interfere with the regular working of the telephone service.

When the tension in the high-voltage line exceeds 500 volts, the arc which forms at the safety fuse is not immediately extinguished, and may, therefore, become even more dangerous than the high-tension current itself. In such cases special devices are necessary in order to prevent the formation of an arc or to insure its immediate extinction when formed. To this end, the wire fuse is enclosed in long glass tubes or imbedded in sand, and no combustible materials must be kept in the immediate neighborhood.. With a view to prevent the bursting of the glass tubes or render the bursting harmless, they are encased in fibrous material. When an intrusive current of sufficient amount arrives at the wire-fuse, the latter is explosively vaporized and the vapor is expelled from the glass tube. The explosion at the same time extinguishes the arc if such be formed. There are various other means of counteracting the overheating of telephone wires and apparatus; but the higher the tension the more complicated and inconvenient are the safety contrivances.

The disturbances considered under II., i. e., the humming produced in telephone apparatus by intrusive undulating or alternating currents, may be avoided by insulating the telephone line as carefully as possible from earth, as well as from any parts which may be connected with the high-voltage line. But when the tension in the latter exceeds 500 volts, that precaution is not always sufficient, the less so because, in practice, it is impossible to maintain either high or low-voltage lines at all points and permanently in a state of perfect insulation. The practical application of both classes of currents frequently involves the necessity of installing the conductors in damp, or otherwise unfavorably situated places, business premises, etc.; and having regard to the high tension of the one class of installation and the extreme sensitiveness of the apparatus of the other, an almost infinitesimal leakage, amounting to only one millionth of the total current, suffices to produce a very marked telephonic disturbance. It is on this account that the juxtaposition of the two can be rendered bearable only by carefully insulating both systems from earth. It is, moreover, but fair to require that the conditions which are imposed upon one class of installation should also be made obligatory upon the other, if it be for the general and public advantage.

[1] From the London "Electrician." Translated by Dr. C. S. du Riche Preller. This paper is a Report just published at Berne (*Blätter für Electrotechnik*), and was kindly communicated by Dr. Wietlisbach to the translator. The translator is of opinion that it strikingly confirms the facts and conclusions recently set forth by him in *The Electrician* (January 10, 1896, "Electric Tramways and Telephonic Disturbances"). The author uses the term "high-voltage currents" (500 volts and above) as contrasted with low-voltage telephone currents.

[2] [The phraseology of what follows is not so clear as could be wished, but it is a faithful rendering of the original.—ED. *E.*]

INTERNATIONAL CHESS BY CABLE.

The Commercial Cable Company has issued a neat little folder giving the details of the recent international chess tournament conducted over its cables. The messages went from Brooklyn to New York, thence through the Narrows and past Coney Island to Cape Canso, Nova Scotia, 850 miles; thence to Waterville, Ireland, 2,161 miles; thence around the south coast of Ireland to Weston-super-Mare, in the Bristol Channel, 329 miles, and thence to London, 143 miles more. The total distance traveled by each message was 3,483 miles, yet the arrangements were so perfect that each player knew what his opponent had done in fifteen seconds after each move was made. Each move was noted on a slip of paper, which was handed to the operator.

BERMUDA CABLE EXTENSION SCHEMES.

Mr. D. Budge, superintendent of the Halifax and Bermuda Cable Company, has gone to Ottawa to ask the government for a subsidy to enable his company to extend its present cable from Bermuda to Jamaica. He says that the West India merchants of Nova Scotia and New Brunswick are unanimous as to the necessity of cheaper rates and a more direct cable service for the development of trade. The present rate from Halifax, N. S., to Jamaica is $1.19 per word. This rate the Bermuda company proposes to reduce to 50 cents per word, if assistance be given by the Dominion and Imperial governments. This, it is claimed, would lead to the opening out of new commercial routes for trade. The project has been favorably received in England.

SECRECY AS TO CABLE TERMINALS.

It has been decided by the Bermuda Cable Company to keep secret the position of their cable from Halifax to Bermuda. The cable goes out the western side of George's Island, Halifax, N. S., but after that its course is not known outside of the office of the company. Its course after leaving the coast is also kept a secret, and is not marked on any of the public charts in use. The cable is considered to be of great strategic importance and its location is desired to be kept secret to prevent any possible attempt in time of war to cut this line of communication between Halifax and Bermuda.

THE UNITED STATES CONDUIT COMPANY has been formed with a capital stock of $25,000 by Jacob E. Ridgeway, W. Miller and S. S. Miller, all of Philadelphia.

ELECTRIC TRANSPORTATION.

CAN ELECTRICITY SUPPLANT THE STEAM LOCOMOTIVE ON TRUNK RAILWAYS?—VIII.

Wm. Baxter, Jr.

THERE are no available data from which the average number or weight of cars in a passenger train can be obtained, but it is very evident that five cars would be a very liberal allowance, and 65,000 pounds for each would more than cover the average weight. Estimating on this basis we would have:

Five passenger cars	162.50	tons.
Locomotive of average weight for passenger service	85	tons.
Average number of passengers, 106 (see Table 8) @ 120 pounds each............	6.36	tons.
Total weight of train..............	253.86	tons.

Weight of locomotive equals 33.4 per cent. of total weight of train. Weight of electric motors required to replace the locomotive and do the same work, 22 tons.

Total weight of trains drawn by electric motors:

Cars	162.50	tons.
Passengers	6.36	tons.
Motors	22.00	tons.
Total	190.86	tons.

Weight of motors equals 11.5 per cent. of total weight of train. Weight of train drawn by electric motors equals about 74.4 per cent. of same train drawn by locomotive. Saving in power required to do the same amount of work in passenger service, about 25.6 per cent.

The saving in power required to move trains of the same weight is, according to the foregoing, nearly 8 per cent. for freight, and over 25 per cent. for passenger service. While the saving in energy in moving freight trains is small, comparatively, the saving in coal would be great, owing to the fact that the efficiency of freight locomotives is much lower than that of engines used in high speed passenger work. If the efficiency of electric motors were dependent upon the speed, as is the case with locomotives, then for freight service the saving that could be effected by the former would not be as great as in passenger traffic; but, taking the facts as they really are, it will be found that in one line of work the gain is about as much as in the other.

In the opening paragraphs of these articles it was shown that the average coal consumption of large engines could be safely taken at two pounds per hour, and the efficiency of transmission was assumed to be 60 per cent., from which we can deduce that the consumption per horse-power delivered on the track would be 3.33 pounds per horse-power hour. In other calculations based on the actual work of freight locomotives on a large number of roads, we have shown that the average result is about 10 pounds per hour. But, in order to not be accused of partiality, we will here assume that freight engines can develop a horse-power at the rate of 6 pounds per hour. The performance of passenger locomotives may be taken as low as 4 pounds. As the difference in cost of coal—owing to the fact that the stationary engines in the power station of an electric system would use a cheap grade—would be about 33.3 per cent., the actual cost of energy delivered on the track would be as follows:

$$\left.\begin{array}{l}\text{Passenger engines}\ldots\ldots 4\ (\text{lbs}) \times 100\ (\%) = 400. \\ \text{Passenger motors}\ldots 3.33\ (\text{lbs}) \times 66.6\ (\%) = 208.\end{array}\right\}\ 50\ \%\ \text{app.}$$

$$\left.\begin{array}{l}\text{Freight engines}\ldots\ldots 6\ (\text{lbs}) \times 100\ (\%) = 600. \\ \text{Freight motors}\ldots 3.33\ (\text{lbs}) \times 100\ (\%) = 208.\end{array}\right\}\ 33.3\ \%\ \text{app.}$$

From these figures we see that the horse-power delivered on the track costs three times as much by steam as by electricity for freight work, and twice as much for passenger service. Now, multiplying these figures by the relative percentages of the power required in both cases to haul given loads, we have:

$$\text{Freight}\ldots\ldots\frac{92.2 \times 33.3}{100 \times 100} = 30.7\ \%.$$

$$\text{Passenger}\ldots\frac{74.6 \times 50}{100 \times 100} = 37.3\ \%.$$

That is to say: The cost of coal consumed to move a given load by electricity is about 31 per cent. for freight and 37 per cent. for passenger work of what it costs by steam.

From these figures we see that the saving in coal is even greater in freight work than in passenger, a result that will surprise many, as it has always been conceded by the friends of electricity that it could only expect to compete with steam in high speed work.

Although these results show that the saving in coal would be greater in freight service than in ordinary passenger work, it must be remembered than in obtaining the ratio between weight of locomotive and passenger train the number of cars was assumed to be five, which is undoubtedly more than the average, but this was done so that it could not be said that the estimate was unfavorable to steam. It is more than probable that if we could obtain the actual relation between weight of cars and engine, we would find that the percentage of coal saving would be about the same for freight as for passenger service. It must not be inferred from this, however, that this relation would hold good at all speeds. When very high velocities are considered, it will be found that the superiority of electricity over steam increases very rapidly, owing to the fact, as already shown, that there is a limit to the power that a locomotive can develop, while, practically, there is no limit to the output of an electric motor. As a proof of the truth of this statement I will here reproduce a table showing the result of tests made by Mr. Angus Sinclair, of the locomotive drawing the Empire State Express on the New York Central railroad:

TABLE 10.

PARTICULARS OF TESTS OF EMPIRE STATE EXPRESS LOCOMOTIVE.

FROM INDICATOR DIAGRAMS.

No. of Diagr'm.	Throttle opening.	Reverse lever notch.	Point of cut-off.	Boiler pressure.	Rev. per minute.	Speed in miles per hour.	Indicated horse power.
1	¼	18	8½	160	160	37.1	648.3
2	¼	18	8½	165	280	60.8	728
3	⅛	18	8½	170	190	44	551
4	⅛	18	8½	170	250	58	871
5	¼	18	8½	160	260	60	960
6	⅜	19	7¼	160	298	69	983
7	⅜	19	7¼	160	304	70.5	977
8	⅜	19	7¼	165	296	68.6	972
9	⅜	19	7¼	165	300	69.6	1,045
0	½	19	7¼	170	304	70.5	1,059
11	½	19	7¼	165	340	78.9	1,120
12	½	19	7¼	165	310	71.9	1,026

An inspection of the last column in this table will show that for the last four observations the power is nearly constant. The fact that the power required at 71.9 miles is less than at 69.6 would indicate that in the latter case the train was going up a slight grade, or else was descending in the former.

It does not seem necessary to give a demonstration here of the truth of the statement that the output of a locomotive is limited, as the fact is so self-evident that it must be conceded without argument. The question, however, to be decided is, what is this limit? If we were to draw our conclusions from this table we would say, about 1,100 horse-power; but in order to be on the safe side we will assume it to be 1,250 horse-power. Taking this figure as the limiting capacity of a locomotive, we can readily show the relation between steam and electricity at high speeds, and, as the matter of more rapid transit between cities is receiving considerable attention at the present time, this is a point worthy of investigation.

PLATTSBURG, N. Y.—The Plattsburg Traction Company has secured a franchise for a six-mile electric road to run from Hotel Champlain to the Normal School, and fair grounds, with a branch to the depot and dock. The project is very popular in Plattsburg, and the company is only waiting for the frost to be out of the ground to begin the construction of the line. The incorporators of the company are: H. M. Pierson, president; H. E. Barnard, treasurer; A. E. Reynolds, secretary; George M. Cole, manager Incandescent and Arc Light, Electric Power and Gas Works; S. M. Weed, H. G. Runkle, D. F. Dobie, T. F. Conway, W. H. Chappel, J. O. Smith, Geo. S. Weed, M. B. Snevily, S. D. Curtis, J. H. Bagg, John B. Riley, W. L. Pattisson, and T. F. Mannix. The power house of the company is of brick and stone. The generating plant consists of Westinghouse incandescent and Westinghouse arc machines, including three 800-light alternators, one sixty 2,000-candle-power arc, and one 500-volt 100-horse-power generator. The converters are Westinghouse, with 225 Shallenberger meters. There are 15 motors on the circuits. In the engine room are two 100-horse-power Ball en-

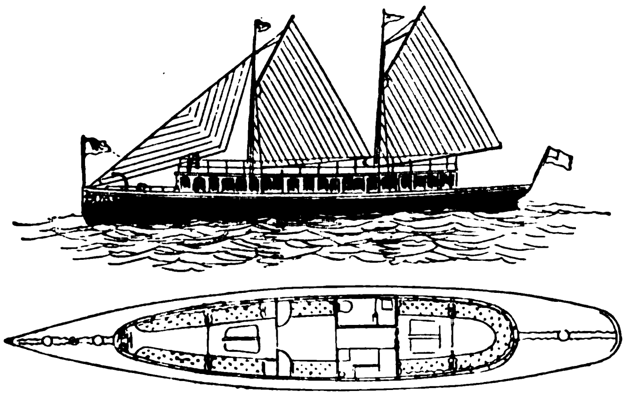
gines, with two 130 horse-power boilers, and three 100-horse-power Hercules water wheels. As a matter of fact, the present plant is that of the Plattsburg Light, Heat and Power Company, the two companies being practically identical.

MR. JOHN JACOB ASTOR'S NEW ELECTRIC YACHT.

MR. JOHN JACOB ASTOR is well known to be an enthusiastic electrician. The building of electric launches in the United States has long lagged far behind the active work of the English builders, and to Mr. Astor's enterprise is owing not a little of the stimulus which has of late been given to the development of this industry on this side of the water.

Mr. Astor's first electric yacht, the "Corsira," was run by a small storage battery. It was last year improved on by the "Progresso," a forty-foot boat. Mr. Astor has now given an order to a Nyack firm for the construction of the largest, finest and most completely equipped electric auxiliary yacht in the world. The boat, which has not yet been named, will be seventy-two feet over all, twelve feet beam, and four feet draught. She will be fitted with twin screws, which will be run by two electric motors capable of developing fifty horse-power. The maximum speed is to be sixteen miles an hour, at 1,000 motor revolutions per minute. Her ordinary speed will be about ten or twelve miles an hour, and her batteries of 480 cells will run ten hours without recharging.

The cells, as well as the motors will be placed entirely below the deck, and will not in any way interfere with the cabin space. The entire boat, decks, planking, and interior finish, will be of polished mahogany, except the quartered oak gun-



MR. J. J. ASTOR'S NEW ELECTRIC YACHT.

wales. The hull will be of peculiar form, having a channel-way for each of the propellers, and there will be two Tobin bronze centerboards, worked by electric capstans from the promenade deck. The boat will be fitted with electric capstans, and a large chamber connected with air pumps will supply air for blowing the whistles, which will consist of a set of chimes. Electricity will also drive the pumps for freeing the boat from water in case of leakage.

In addition to her battery equipment, the new yacht will be rigged as a schooner, and will have ample sail plan in case her machinery is disabled. The yacht is being constructed by Charles D. Mosher, the designer of the fast yachts, "Norwood," "Feiseen," and "Yankee Doodle," and is to be finished by June 1.

MARRIED.

MR. C. I. HILLS.

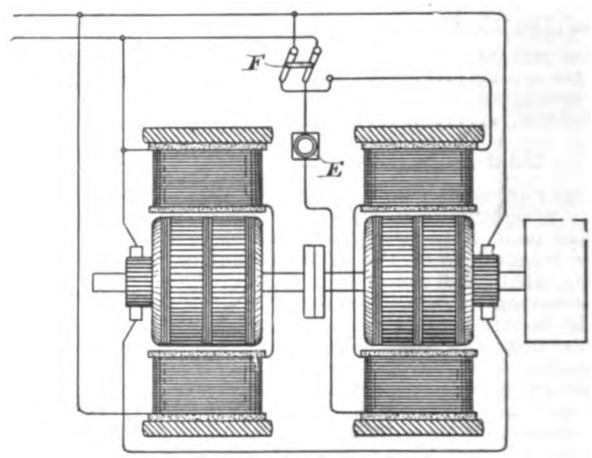
Invitations have been sent out for the marriage of Mr. Charles I. Hills, and Miss Matilda King, of Elizabeth, N. J., which will be celebrated in Westminster Church, Elizabeth, on Wednesday afternoon, April 24, at 4 o'clock. Mr. Hills is well known to every one in the electrical business, having for years been connected with the old Perkins Electric Lamp Company. For a time during the lamp troubles, Mr. Hills was associated with the Columbia Incandescent Lamp Company, of St. Louis, but when the Perkins Electric Switch Company, of Hartford, began the manufacture of incandescent lamps, he severed that connection and became New York agent for the latter company. Since that time he has been appointed general manager for the sales department with offices in the Havemeyer Building, New York, and has established a large business. There is no better known nor better liked man in the electrical trade than Mr. Hills, and his hosts of friends are offering him congratulations on his approaching marriage.

POWER TRANSMISSION.

BURKE'S METHOD OF REGULATING MOTORS.

IN the operation of electric motors from supply circuits, conditions are sometimes encountered in which a wide variation of speed is desired or essential. An example of this is a condition in which, for instance, it is required to deliver 10 horse-power at any speed between the limits of 100 and 500 revolutions, and to maintain this delivery at any desired speed between the limits above referred to.

To accomplish this result, there have been two methods in use, one of which is to vary the speed by interposing resistance in the armature circuit, thereby reducing the voltage on the armature and consequently the speed. This method has the disadvantage that there is a comparatively large loss in the resistance, and consequently a low efficiency. The other method is to reduce the voltage upon the armature of the motor by introducing a rotary transformer between the supply circuit and the motor to be operated, which transformer is so arranged that the voltage supplied to the motor may be varied between the limits of zero and a predetermined maximum. This method has the disadvantage of a large investment in dynamo machines, because the rotary transformer used consists of a primary motor and a secondary generator, each of



BURKE SYSTEM OF MOTOR REGULATION.

which has an output equal to that of the main motor to be operated.

In the method about to be described, instead of using one motor, two machines are used, each of which will give one half the desired delivery. For instance in the condition previously referred to, two motors of five horse-power each at 100 revolutions are operated in unison, and co-operate with each other so as to fulfill the requirements of 10 horse-power delivery at any speed between the desired limits.

The accompanying illustration shows a diagrammatic embodiment of the method. The machines are coupled directly, E representing a rheostat, and F a reversing switch.

The action in general is as follows: In starting and when operating at minimum speed, the two machines are acting in unison as motors. The speed is gradually increased until it reaches its predetermined maximum, first by reducing the field of one of the machines, thereby transferring the voltage of the line to the other, and then by reversing the field on the former machine and gradually increasing it, thereby adding to the line voltage the voltage of the former machine, the latter machine receiving the combined voltage. This method is due to Mr. James Burke, of New York.

ELECTRICAL EVENTS AT NIAGARA FALLS.

The announcement is made that the Niagara Central Railroad, which is about 12 miles long and runs between Niagara Falls, Ont., and St. Catharines, Ont., will this spring adopt electricity as a motive power. It is stated also that as a steam road, the Niagara Central has not been over-profitable, and it is expected that electricity will bring about a radical change in this respect. The road runs through a good country, and there is no reason why electricity should not prove a beneficial change.

It now looks as though the Niagara Falls Hydraulic Power and Manufacturing Company would receive a franchise from the Legislature of this State, the Assembly having passed the

bill confirming and defining certain riparian rights of the company. There is no opposition to the bill, the commissioners of the State reservation having approved its provision that the company be allowed to develop 100,000 horse-power, which is the same amount as the capacity of the tunnel of the Niagara Falls Power Company.

One day recently a number of Cornell College students paid a visit to the plant of the Niagara Falls Power Company at Niagara Falls. While there they made a 500-volt short circuit. The result was that the fuses were blown out with a startling explosion, while the wattmeter they brought with them was demoralized. Naturally, the students were somewhat frightened.

THE SODA AND POTASH WORKS AT NIAGARA.

THE Walton Ferguson Chemical Company's plant at Niagara Falls will be started in April or May. This plant is the latest one built on the land of the Niagara Falls Power Company. At present it consists of two buildings, one of which is 60 x 125 feet, and the other 30 x 60 feet. Both are two stories high and built of wood. This company will manufacture potash and soda electrically on a large scale, and no doubt their influence will be felt on the market.

All the electrical appliances, transformers, etc., will be located in the smaller building, while on the upper floor of the larger buildings will be placed the large porcelain-lined iron tanks designed to contain the crude material for the manufacture of potash and soda. These tanks will be about 100 in number, and they will form one of the features of the electrical industrial development at Niagara Falls. In size they are expected to be about the largest vessels ever made with complete and unbroken porcelain lining. A large portion of the lower floor will be devoted to office room and the boxing and shipping departments.

When the plant begins its work it will consume about 1,000 horse-power, but it is intended to enlarge the factory until it shall be about eight times its present size, and then its capacity will be likewise increased. It is probable that all future buildings erected by this company will be built of brick. In the case of the two buildings just erected they were deterred from using either brick, stone or iron, fearing the action of the gases generated would prove detrimental, but now they are confident brick will be a safe material to use, and they will adopt it.

One ton a day will be the capacity of the present plant, and the rock salt for making soda will be obtained in Syracuse. From Germany will come the crude material for making potash. The product of the company at first will be put up in packages of 100 lbs., but later on they will adopt a canning process controlled by them. In this process machinery will be used, and the cans packed in cases by hand ready for shipment. As yet the subway in which the cables carrying power to the aluminum and carborundum works have not been extended so far as the carbide or soda plants, but they soon will be, and until they are, the power will be conducted by cables carried above ground.

A MULTIPHASED SHOE SHOP.

The operation of shoe factories by electricity seems to be making steady headway. A few weeks ago we noted the equipment of the large Drew-Selby plant in Ohio, with electric motors throughout by the General Electric Company. The same company is about to undertake the electrical equipment of the Norway Shoe Shop Company, of Norway, Me. Seven non-synchronous multiphase motors, aggregating 100 horse-power, will be put in. The current will be taken from the 250-kilowatt, three-phase generator recently set up in its station by the Norway Electric Light Company.

COLUMBIA, S. C.—The following contracts have been awarded for the power plant for the Columbia Water Power Company, to cost over $200,000 (A. G. Stevens, engineer, Manchester, N. H.): W. A. Chapman & Co., Providence, R. I., power house, forebay races and wheel pits, setting wheels and electric generators; General Electric Company, Boston, Mass., eight electric generators; Rodney Hunt Machine Company, Orange, Mass., eight pairs McCormick waterwheels of 1,300 horse power per pair; total, 10,500 horse power; 29 feet fall.

THE UNITED VERDE CO., Arizona, are putting in an electric power plant to be used for all the underground work in their mine, supplanting all steam power.

HIRAM S. MAXIM is going to write a series of articles on automatic firing guns for "Industries and Iron".

EDUCATIONAL.

COLUMBIA UNIVERSITY'S NEW ENGINEERING BUILDING.

THE Engineering Building, which is soon to be erected on the Columbia University grounds at Morningside Heights, will contain the departments of civil, mining, mechanical, and electrical engineering. It will be 150 feet long, by 55 feet, and will have 52,000 square feet of floor space. The greatest care has been exercised in the general design of its construction, and

THE NEW ENGINEERING BUILDING, COLUMBIA UNIVERSITY, NEW YORK.

in one respect especially, that of ventilation, its arrangements show admirable judgment. An idea of the amount of air that will be forced through the building can be obtained from the fact that two twenty-five horse-power electric motors will be required to operate the supply fans, and three ten horse-power motors to operate the exhaust fans. The large lecture room in the center of the building will seat 450 students. It will be lighted from the dome as well as from the sides, and its extreme height will be 40 feet. On the third floor, the east wing will contain the qualitative and the west wing the quantitative laboratory. Each laboratory will have 4,000 feet of floor space. The body of the building will contain a chemical laboratory and reading room, a laboratory for electrolysis, and gas analysis, and another for water and volumetric analysis, and a photometric room.

THE NEW CASE SCHOOL ELECTRICAL LABORATORY, CLEVELAND.

THE growth of the electrical engineering department of the Case School of Applied Science, Cleveland, and the rapid accumulation of apparatus and laboratory appliances caused by the progressive policy of the management, have

THE NEW ELECTRICAL LABORATORY,
CASE SCHOOL OF APPLIED SCIENCE, CLEVELAND, OHIO.

made a new building for the department a necessity. The building was begun early in the summer of 1895, and is now completed. It is situated near the mechanical engineering

laboratory. The power for driving the dynamos is furnished by the Corliss engine in the shop, and steam for heating is taken from the boilers in the machine ship boiler room. The shafting and the return pipes are all carried in a covered conduit running from the mechanical to the electrical building.

The building is 104 feet long and 64 feet wide. The basement is occupied by a large dynamo room, 60 feet square, and three smaller laboratories. On the first floor are the lecture room, testing rooms, and an office for the professor of the electrical department. On the second floor is an assembly room 60 feet square, with rows of seats rising gradually to the rear of the room. This room will hold nearly 600 people, and is said to be one of the finest lecture halls in the city. The top floor has a drawing room 60 feet square, lighted by a skylight, and some smaller class rooms. The building will be lighted throughout by electricity, and heated by steam. It will be ready for occupancy next fall, and will be a most valuable addition to the resources of the electrical department of the school.

CORNELL UNIVERSITY REGISTER FOR 1895-6.

The Register for 1895-96, of Cornell University, shows conclusively that Ezra Cornell's intention to "found an institution where any person can find instruction in any study," has been carefully borne in mind in the maintenance of the curriculum of the splendid university which he founded. As Dr. R. H. Thurston, in a recent paper on the needs and opportunities of a great technical college, says:

"Among the great opportunities of the world, in the promotion of the best interests of the people, are those to-day to be found at Cornell University and largely in connection with the organization of Sibley College. Original research is now universally recognized as the 'essential preliminary to the fullest development of industry,' and the thousands of schools of France and Germany and all their technical colleges and their universities, whether technical or other, are organized in recognition of this fact. The hundred weaving and designing schools of England, her technical colleges, and her trade schools are taking a similar constitution, and in Manchester alone 14,000 students are nightly profiting by the systematic manner in which that nation has entered upon the task here set before Cornell University by our own nation and State. Yet nowhere can be found a better substructure and larger opportunities for the erection of an orderly and systematically planned and mutually helpful aggregation of colleges and schools than in the United States and at Cornell University to-day."

It is gratifying to see that the standard of electrical training, which has for a long time been a special feature of Cornell, is being adjusted to meet the requirements of the rapidly widening electrical field.

PERSONAL.

MR. J. H. VAIL.

It will be a source of pleasure to a wide circle of friends and acquaintances to learn that Mr. J. H. Vail, dating from April 1, has been appointed engineer-in-chief of the Pennsylvania Heat, Light and Power Company, of Philadelphia, and also of the Edison Electric Light Company, of Philadelphia. He will also have engineering charge of all the sub-companies that have recently been consolidated in the Quaker City. The system thus entrusted to Mr. Vail's care, experience and fidelity is simply enormous, but they who know the man are satisfied that he will discharge his responsibilities to the full. It will be readily understood that the new developments will require a considerable readjustment of plans and plants, but Mr. Vail's work peculiarly qualifies him for success in that difficult field.

MR. J. ELLIOT SMITH, the Superintendent of Fire Telegraphs of New York City, has been suspended from duty, pending further investigation of serious charges against him, on the score of favoritism and paying high prices for supplies. His friends claim that commercial animus is back of the charges, and that he will be vindicated.

MR. R. E. WRIGHT of Allentown, Pa., has been re-elected president of the State Electric Light Association of Pennsylvania.

DINNER TO MR. E. M. SCRIBNER.

A dinner was given by Mr. Chandler of the American Circular Loom Company, Chicago, to Mr. E. M. Scribner who is leaving the Western Electric Company, to take the place of business and sales manager for the Bryant Electric Company, of Bridgeport, Conn.

The affair took place at the Great Northern Hotel April 2, and was attended by Messrs. Crandell, Wilkinson, and Scribner, of the Western Electric Company; Mr. Wolff, of the N. Y. Insulated Wire Company; Mr. Morse, of the Kerite Company; Mr. Chas. E. Brown, of the Central Electric Company; Prof. John P. Barrett, and Messrs. Brooks and Chandler, of the American Circular Loom Company.

MR. W. D. SARGENT, manager of the New York and New Jersey Telephone Company, has recovered rapidly from his recent surgical operation. He has the nine lives of a cat, and will probably be quoted in the middle of the next century as a striking instance of the longevity of electricians.

OBITUARY.

W. H. WHITACRE.

William H. Whitacre, a leading citizen of Alliance, O., for many years passenger conductor on the Cleveland and Pittsburg Railroad, died on April 2, aged 57. Several years ago he built the Alliance Electric Railway and was general manager of the company at the time of his death.

WM. S. BEATTY.

The many friends of Mr. Wm. S. Beatty, of the Pittsburg office of the General Electric Company, will be pained to learn of his death, April 7, in New Orleans. Mr. Beatty was obliged to give up his work some weeks before, on account of failing health, and to seek a more congenial climate in Florida, and later in Arizona. Finding no improvement, however, he was on his way home, but on reaching New Orleans was unable to proceed further. Mr. Beatty was a comparatively young man for the position he filled, and had marked abilities which gave great promise for a brilliant future. His agreeable and obliging manners made him friends everywhere, and his sudden death comes as a great shock to them all.

JUSTIN J. GATES.

Our readers will be sorry to learn of the death of Mr. Justin J. Gates, who died at his home a few days ago from an attack of typhoid fever. Mr. Gates was particularly well known in the incandescent lamp business, having been associated with manufacturers of incandescent lamps for many years. His first association with an electric company was when he entered the employment of the Mather Electric Company as bookkeeper, shortly afterwards resigning to become the secretary and general manager of the Perkins Electric Lamp Company, a company which Mr. Gates was himself prominent in organizing.

Mr. Gates was well known in connection with this company until it was forced to suspend operations owing to the incandescent lamp litigation, after which he associated himself with the Waring Electric Lamp Company, of Manchester, who manufactured the Novak lamp, and which company was also forced to suspend operations by litigation before many months. Some time later Mr. Gates was appointed to the position of general manager of the Perkins Electric Switch & Manufacturing Company, of Hartford, when they commenced manufacturing incandescent lamps. This position he held until quite recently, when he retired, and at the time of his death was busily engaged in the lamp business for himself.

Mr. Gates was always prominently known to purchasers of incandescent lamps, and his uniform courtesy and business integrity won for him hosts of friends, who will all join with us in regrets that he should have been carried away at this time while just in the prime of life.

WARREN ELECTRIC AND SPECIALTY CO.

The above company, of Warren, O., forward us their catalogue of incandescent lamp specialties. It is their first publication on the subject, and gives evidence of energy and enterprise. In the manufacture of their filaments, they use both bamboo and cellulose, and they make any efficiency from 3 up to 4½ watts per candle. Their catalogue shows a range of 10 and 16 candle-power lamps, but they make also 4, 6, 8, 32, 50 and 100 candle power, and have ready also a line of colored lamps. All of their product is supplied with base as ordered. The manufacture of their lamps is under the expert guidance of Mr. F. E. Cavanaugh. The officers of the company are T. H. Gillmer, C. H. Angstadt and E. W. Gillmer. The headquarters are at 670 West Market street, Warren, O.

Exhibition Notes.

WHAT EXHIBITORS WILL DO.

LAST week we printed a number of notes as to what exhibitors at the National Electrical Exposition propose doing. This week we are able to furnish further interesting details.

The Crouse-Tremaine Carbon Company, of Findlay, O., will exhibit samples of their solid and cored carbons for arc lighting purposes. They will also have a nice display of their motor and generator carbon brushes, and other specialties.

The Holtzer-Cabot Electric Company, of Boston, propose to exhibit dynamos, motors, controllers and indicators of their special make, and of various design. They will also have on view other apparatus and supplies of their own manufacture.

The American Carbon Company, of Noblesville, Ind., will have a fine display of their various carbon specialties. The exhibit will be in charge of Mr. E. F. Peck, who is their New York agent.

The Bradford Belting Company, of Cincinnati, will exhibit their "Monarch" insulating paint and their "Dynamo" belting.

J. C. Vetter & Co., of New York City, will have a very interesting and complete exhibit in electro-therapeutics. It is intended to illustrate the flexible application and perfect control of the current in this field, and will include the Vetter current adapter, Vetter carbon current controller, Vetter volt selector, and standard milliammeter. A new feature will be the volt selector, which enables a medical practitioner to take voltage of any desired figure from the regular 110-volt current. The concern will also demonstrate the application of the current for cautery purposes.

Mr. T. H. Brady, of New Britain, Conn., will be in New York next month with his entire line of mast-arms, hoods, brackets, storm protectors, etc. A special novelty to be shown is his new arc cut-out box.

The Payne Engine Company will exhibit one of their 50-horse-power high-speed engines, direct connected to a 25-kilowatt Cincinnati Card dynamo. The engine will embody all the latest improvements of the company, including a new shaft governor, and the automatic circulation of oil on the main bearing.

The Kennedy Valve Manufacturing Company intend to exhibit a line of their high-pressure valves, designed especially to meet the requirements of modern electric light and power plants. This exhibit will consist chiefly of their extra heavy gate valves, iron body, bronze mounted, with self-packing stems; and of their patent renewable copper seat globe valves. The distinctive feature of the latter is that they are the only globe valves in which the seat can be removed and renewed without withdrawing the valve itself from the line of piping. The company will also have on view a line of their standard goods, the whole exhibit occupying about 100 square feet.

The American Stoker Company, of Dayton, O., will have one of their stokers placed in position on the floor feeding coal. It will show the distribution of coal over the grate surface, the driving mechanism, and the ease and simplicity of the actuating movements.

L. Katzenstein & Co., of New York City, will make an exhibit of their metallic packing for piston rod and valve, stem stuffing boxes, flexible tubular metallic packing for slip joints, improved slip joints, and metallic gaskets for all kinds of flanges.

The Columbia Incandescent Lamp Company, of St. Louis, will make an effective exhibit, although President Rhotehamel declines to disclose its exact nature for the present. All the company's specialties in lamps are to be in use.

The R. D. Nuttall Company, of Allegheny, Pa., will make an exhibit of their various electric railway specialties.

Huebel & Manger, of Brooklyn, manufacturers of electrical and brass goods, will have a neat display of their various specialties.

The Standard Paint Company will have a very interesting exhibit of their P. & B. products in the line of insulating paints, illustrative of the uses made. They will also have an excellent display of the "Ship" cored carbons of Schiff, Jordan & Co., of Vienna. The whole exhibit will occupy not less than 250 square feet.

Chapin Douglas Electric Company, 136 Liberty street, New York City, will exhibit a full line of the specialties manufactured by them, including the "Perfection" dynamo brushes, made of gauze copper wirecloth. These brushes are wound in such a way that contact is made on the end of all the wires, and there is no loose end to cause sparking. The brushes are very compact. Their C.-D. rosette, recently illustrated in this paper, is new and differs from others in the contact and mode of holding the cap to the base. Burnley's soldering paste is a new soldering flux, which is non-corrosive and contains no acid. A number of joints will be shown which will illustrate its utility in soldering wires. As agents for the well-known firm of Eyanson & Armpriester, the Chapin Douglas Electric Company will have in their exhibit a switchboard with latest designs in switches and instruments, including the Eyanson quick-break switch.

The E. T. Burrowes Company, of Portland, Me., will have an attractive display, including models of both their open and closed car curtains in pinch handle and cable styles; also a full line of curtain materials and fixture accessories. They will also exhibit the application of their waterproof material called oakette, which has proved very durable for open car curtains.

The Stanley Electric Manufacturing Company, of Pittsfield, Mass., expect to have in their exhibit at the approaching exposition one of their generators, with all the various parts shown separately; an exciter, a two-phase motor, a number of transformers, and a lot of switchboard apparatus.

A. K. Warren & Co., of New York, will have one of the most interesting exhibits, as it will show up the internal mechanism of apparatus, and give the public an idea how dynamos and motors get damaged and how they are repaired. The processes and materials will be practically illustrated. The company will also exhibit their brass alloy woven wire brushes, and a new brush holder, which they have lately perfected. They will also show in operation the machine used for turning down and smoothing rough commutators, and in a general way will exemplify the class of work that has to be done on emergency calls.

Eugene Munsell & Co. will lay before the public gaze a large display of mica in all its various forms. The exhibit will include large samples of mica as it comes in rough from the mines, and in the sheet; mica segments for railway motors, and mica in the shape of electrical insulation for all manner of purposes.

The Walker Company, of Cleveland, will exhibit in the basement, among the larger apparatus, an 80-kilowatt direct connected generator which will be installed in the basement of the building as a part of the general power plant. This machine will be direct connected to a tandem compound Dick & Church engine, built by the Phoenix Iron Works, of Meadville, Pa. It will be one of their standard compound wound dynamos for isolated incandescent lighting work. On the main floor the company will make a further exhibit, consisting of miscellaneous appliances for railway and lighting work; and this will also be the headquarters for the distribution of their literature.

The Peru Electric Manufacturing Company will group their exhibit in a tasteful booth, in which will be displayed their Laclede and Hercules batteries, as well as a full line of the different shapes and styles of porcelain which they manufacture for electrical purposes.

Stanley & Patterson will have a nice exhibit, including their general electrical supplies, and as Eastern agents they will also display lines of goods made by the New York and Ohio Company, Brunt & Thompson, Indiana Rubber and Insulated Wire Company, and E. G. Bernard Company, these manufacturers representing respectively lamps, porcelain, wires and cables, and dynamos and motors.

The National Carbon Company, of Cleveland, will make a general display of their carbon goods.

The Riker Electric Motor Company, of Brooklyn, will exhibit a line of their standard goods, consisting of two or three motors, a direct coupled dynamo, and engine plant, and some of their 1896 fans.

Henry R. Worthington will exhibit a number of electrically driven pumps, which they manufacture, most of which are of new design. They will have in active operation an electric house tank pump, also several sizes of horizontal and vertical electric pumps, of special design for different services, including a triplex steeple power pump geared to an 80-horse-power motor. They will also show a number of interesting studies of hydro-electric machinery for elevator service, water works supply, fire protection, etc.

Partrick & Carter Company, of Philadelphia, will make an interesting exhibit sure to catch the public fancy, dealing as it will with domestic uses of the current. It will include working samples of their house and hotel annunciators, return call and fire alarm hotel systems; also a complete line of their bells and general apparatus, all in working order. In addition to these, they will have two or three cases for holding their smaller goods, so that the trade can examine the whole line, varied and extensive as it is. The company will have two or three representatives on the ground all the time.

The Fuel Economizer Company of Matteawan, N. Y., will make an exhibit of specimen castings of their Green machinery, showing the latest improvements, drawings and blueprints in regard to different installations now at work, and data will be given out on the subject.

Mr. Hugo Reisinger, New York, will exhibit (1) "Electra" high-grade Nürnberg carbons for arc lighting for direct current and alternating current lamps. (2) All descriptions of the very finest grade of microphone carbons used in the manufacture of telephones. (3) A large variety of the very finest grade of battery carbons. (4) Carbons used for searchlights, for the production of aluminum, and for the electric smelting of all kinds of ores. The "Electra" factory, whose product will be shown, was one of the first to make arc light carbons and is said to be by far the largest concern of the kind in Europe.

FROM NIAGARA TO NIAGARA IN NEW YORK CITY.

THE completion of the electric power plant at Niagara, and the recent contract made by the city of Buffalo for its delivery within the city limits, by June, 1897, makes it appropriate that the work should be signalized in some way at the National Electrical Exposition in May. With this end in view, the management have secured a beautiful model, made by Mr. G. R. Allen, of Philadelphia, for the Hon. Peter A. Porter, of Niagara Falls, to scale, under the direction of Dr. Coleman Sellers, of the Niagara River, the power house, the town, and the long discharge tunnel. The turbines are seen in actual play, operated by water from the canal and driving the big generators. The model is 12 feet by 4, and will be given a place of honor on the main floor. The happy thought has occurred that as little power is required to drive the turbines, it might be comparatively easy to switch on a modicum of current from the Falls plant and actually run the model with it, not as an ideal exemplification of what might be done, but more as a pretty tour de force. To get the circuit was the problem, but General Eckert, president of the Western Union Telegraph Company, has authorized Mr. A. S. Brown, the electrical engineer of the company, to place two of their ordinary copper commercial wires at disposal, for use every evening, say for an hour or so, when the weather conditions are normal. This is a generous offer evincing no small amount of public spirit, and does great credit to the company. Mr. L. B. Stillwell, of the Westinghouse Company, has been asked to co-operate with Mr. Brown in working out the details, it being the intention to use the Tesla two-phase system and Tesla two-phase apparatus. A further suggestion is to hang some American Bell long distance telephones over the exhibit and thus listen to the roar of Niagara while seeing the model driven by it; and steps are now being taken to realize this. Yet another really brilliant idea, suggested by Mr. Stillwell and quite likely to be executed, is to deliver some of the Niagara current to condensers and cable to Europe with it. Mr. Tesla is greatly interested in the whole project and is lending it his active assistance.

MR. EDISON'S PERSONAL EXHIBIT AT THE ELECTRICAL EXPOSITION.

Mr. Edison is already preparing a select personal exhibit for the National Electrical Exposition, and Mr. Luther Stieringer has kindly consented to give it his own attention for arrangement. Mr. John Ott, one of Mr. Edison's assistants at the Orange laboratory, is now putting the apparatus in order for display. There are 40 cases.

In telegraphy, Mr. Edison will show stock printers, the phonoplex, the quadruplex, American District system, train telegraphy, and his vote recorder, the first invention he ever made.

In telephony, he will show several varieties of apparatus, including microphones, the chalk transmitter, motograph receiver, etc. He will also show his interesting megaphone, odophone, etc.

In lighting, Mr. Edison will show his earliest incandescent lamps, first converter, models of systems of distribution, multiple carbon lamps, center pole lamps; first chemical meter; lamp Leyden jar; platinum lamp, etc.; also the first fixtures used.

In the line of power transmission, Mr. Edison will exhibit some very early motors and models of great interest.

Among miscellaneous exhibits may be named his pyromagnetic motor, etheroscope, tasimeter, stages illustrating the evolution of the bamboo filament, magnetic friction devices, early phonographs, his recent fluoroscopes and his latest phonographs.

He has also in course of construction four sets of apparatus with which experts from his own staff will give exhibitions of the Röntgen rays, so arranged that by using the fluoroscope put into their hands, people can inspect their own anatomy. The Crookes tubes will be mounted in connection with mercury pumps, so that in a rough way the process of lamp exhaustion will also be demonstrated.

UNITED STATES PATENT OFFICE EXHIBIT.

The United States Patent Office is arranging to make at the Electrical Exposition a fine display of electrical models, etc., which will be peculiarly interesting and instructive as bearing upon the growth and development of electrical invention. A special representative of the Patent Office will be in charge of this exhibit, which will be under the general care of the historical and loan exhibit committee.

A GOLDEN KEY TO OPEN THE EXPOSITION.

Gen. E. S. Greeley has kindly consented to loan for the purpose of opening the National Electrical Exposition, the gold telegraph key used by President Cleveland at the World's Fair in 1893. It is proposed that when Governor Morton closes the circuit through the key to the power plant, instead of signaling merely from floor to floor of the Exposition Building, a circuit shall first be made across the Continent and back, through Chicago and San Francisco. The action will practically not be less instantaneous, but it will graphically illustrate the speed with which electricity travels. It is proposed also to fire a signal cannon in the same way, at the same time, to announce the event.

ANOTHER LONG LIST OF EXHIBITORS.

The management of the National Electrical Exposition publish in our advertising pages a list up to Friday last of companies that have taken space. The names not already given in our reading columns are printed below. We are informed that a large number of concerns are still applying for space, and that considerable difficulty begins to be experienced in finding room for them: Anchor Electric Company, Boston, Mass.; Ashcroft Manufacturing Company, New York; Boynton Multivolt Battery Company, New York; Brush Electric Company, Cleveland, O.; Clonbrock Steam Boiler Company, Brooklyn, N. Y.; Consolidated Safety Valve Company, New York: Adam Cook's Sons; Curtis Hull Manufacturing Company, Hartford, Conn.; Electrician Publishing Company, Chicago; General Incandescent Arc Lamp Company, New York; Hall, Geo. P., & Son, New York; Hayden & Derby Manufacturing Company; New York Carbon Works, New York; Pass & Seymour, Syracuse, N. Y.; Searles, A. M., Chicago; Simmons, John C., New York; Taunton Locomotive Manufacturing Company, Taunton, Mass.; Warren Electric Company, Chicago; Watertown Engine Company, Watertown, N. Y.; Diamond Electric Company, Chicago, Ill.; Burhorn & Granger, New York; Buyers' Reference Company, New York.

SOCIETY AND CLUB NOTES.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The 105th meeting of the Institute will be held at 12 West Thirty-first street, New York City, on Wednesday, April 22, at 8 p. m., when a paper will be read by Mr. D. McFarlan Moore, a member, of Newark, N. J., on "Recent Developments in Vacuum Tube Lighting," accompanied by experiments. The hall will also be lighted by these tubes.

"JACK OF ALL TRADES."

A New England friend sends us the following "dodger," issued by an electrical supply company in his vicinity, as an exhibition of unsurpassed versatility:

Also a full line of electric supplies, including bells of all kinds, batteries, electric fixtures, and a full supply of electric lamps at low prices.

Estimates furnished for electric lighting and bells, telephones, speaking tubes, and motor work. Satisfaction guaranteed.

All kinds of locks and keys made to order, and locks of all kinds repaired and opened. Light machine repairing and grinding. Axes, knives, scissors, and skates sharpened. Saws filed, lawn mowers sharpened, and a full line of trunks and bags sold at low prices, and made to order if desired, at short notice.

Clothes wringers and carpet sweepers of all kinds repaired and sold, also sewing machines repaired.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS, ISSUED APRIL 7, 1896.

Alarms and Signals:—

PRESSURE ALARM FOR GAS PIPES. F. S. Baker, Chicago, Ill., 556,534. Filed Jan. 17, 1895.
The terminals of the electric current are located within both ends of a two-limbed vessel containing mercury; the level of which varies with the pressure.

ELECTRIC INDICATOR FOR HOT JOURNAL BOXES. W. B. Chockley, Denver, Colo., 557,650. Filed March 15, 1895.
Details of construction.

Primary Batteries:—

GALVANIC BATTERY JAR. C. C. Dusenbury, New York, 557,779. Filed Dec. 23, 1895.
Provides an air-tight cover.

Storage Batteries:—

STORAGE BATTERY. A. F. Vetter, New York, 557,920. Filed Aug. 30 1895.
Consists of plates inclosing the active material and provided with downwardly inclined openings for the circulation of the electrolyte.

Conductors, Conduits and Insulators:—

INSULATOR. C. E. Peterson, Stratton, Neb., 557,600. Filed Nov. 11, 1891.
A metal rod pointed at one end, a spiral coil of wire secured to the opposite end of rod and retained in engagement with a screw-threaded insulator.

WIRE-CONNECTOR. C. H. McIntire, Newark, N. J., 557,690. Filed Feb. 15, 1896.
An oval metal tube slit longitudinally adapted to be twisted together with the inserted wires.

CONDUIT FOR ELECTRICAL CONDUCTORS. J. M. Kinney, Boston, Mass., 557,830. Filed Aug. 6, 1895.
A series of layers of paper first saturated with alum and coated with a mixture of bichromate of potash, glue and diatomite.

INSULATOR. H. W. Rappelye, Philadelphia, Pa., 557,881. Filed Feb. 24, 1896.
Employs a clamp to hold wire in position.

Dynamos and Motors:—

COMMUTATOR BRUSH HOLDER. R. Hirsch, Milwaukee, Wis., 557,678. Filed July 1, 1895.
Employs a spring controlled arm adapted to bear against the rear end of the brush so as to press the latter into electrical contact.

ELECTRIC MOTOR. I. E. Storey, Hornellsville, N. Y., 557,714. Filed Jan. 28, 1893.
A multipolar motor having a single field-magnet coil.

ARMATURE CORE. G. F. Packard, Fort Wayne, Ind., 557,869. Filed Dec. 26, 1895.
A laminated core of segmental punchings having apertured ears for the fastening bolts.

ROTATORY FIELD MOTOR. C. S. Bradley, Avon, N. Y., 557,957. Filed Sept. 30, 1895.
The method of regulating an alternating current motor consisting in increasing the capacity-inductance product of its secondary circuit or circuits as the speed increases. Primary and secondary windings are provided for the two members of the motor.

FRAME FOR DYNAMO MACHINES. F. Bain, Chicago, Ill., Design Patent, 25,365. Filed Dec. 24, 1894.

Electro-Metallurgy:—

ELECTROPLATING COPPER. W. B. Hollingshead, Bronxville, N. Y., 557,816. Filed Sept. 23, 1889.
A bath composed of 12 parts of ammonium cyanide, 61 parts of potassium tartrate (neutral), 27 parts of a mixture of water and oxide of copper mixed to a paste, and water.

Lamps and Appurtenances:—

ELECTRIC ARC LAMP. T. Reyman, New York, 557,606. Filed July 9, 1895.
Details of construction.

ADJUSTABLE INCANDESCENT LAMP HOLDER. E. Wade, Lawrence, Mass., 557,732. Filed July 1, 1895.
Details of construction.

SHADE FOR ELECTRIC LIGHTS. W. E. Robinson, Faribault, Minn., 557,888. Filed June 20, 1895.
A shade leaf adapted to clasp the globe of the lamp by means of a spring and clamp.

ELECTRIC ARC LAMP. H. E. Bradley, Pawtucket, R. I., 557,648. Filed Feb. 6, 1896.
Employs a star-wheel actuated by the weight of the upper carbon rod, in combination with a pendulum.

Miscellaneous:—

PRESSURE GAGE. T. M. Gordon, Cambridge, Mass., 557,989. Filed June 7, 1895.
An electrical terminal in continuous contact with a pointer, and a plurality of holes spaced apart throughout the length of the dial plate. Designed to give an alarm.

WINDING DEVICE FOR ELECTRIC CABLES IN ELEVATORS. D. E. Houser, Fort Wayne, Ind., 557,819. Filed Aug. 16, 1895.
Provided with a series of annular contact rings adapted for engagement with corresponding series of brushes, arranged in the signaling circuit.

Railway and Appliances:—

ELECTRIC RAILROAD. W. R. Elliott, Chicago, Ill., 557,657. Filed June 27, 1895.
A magnet adapted to be used on an electric car for actuating a contact-making device.

CLOSED CONDUIT AND APPLIANCE FOR ELECTRIC RAILROADS. W. R. Edelen, Washington, D. C., 557,784. Filed Nov. 16, 1895.
Consists of a series of covers having no visible opening, manipulated through the medium of a tilting cover, operated by a shoe attached to the car.

ELECTRIC CAR TRUCK. C. F. Baker, Boston, Mass., 557,535. Filed Sept. 16, 1895.
Comprises an outer and an inner frame with longitudinal spaces between them at the sides.

TROLLEY MECHANISM. J. M. Kennedy, Hollidaysburg, Pa., 557,827. Filed Nov. 23, 1895.
A trolley having adjusting means operated from the interior of the car.

HANGER FOR TROLLEY WIRES. W. A. McCallum, Avondale, O., 557,860. Filed June 24, 1895.
Details of construction.

ELECTRIC PROPULSION OF CARS. A. H. Brintnell, Toronto, Canada, 557,960. Filed May 1, 1895.
A system in which the motor is composed of drum armatures and employing field magnets located at requisite distances apart between the rails of the track.

ELECTRIC RAILROAD BOND. B. Ford and W. Jens, Johnstown, Pa., 558,016. Filed July 22, 1895.
A rail having integrally attached thereto a flexible extension, having at its free end a head for attachment to an adjacent rail.

Switches, Cut-Outs, etc:

AUTOMATIC ELECTRIC RAILWAY SIGNAL. W. W. Alexander, Kansas City, Mo., 557,749. Filed Dec. 10, 1889.
A power train of wheels, operating simultaneously a semaphore, and a message transmitting device.

ELECTRIC SWITCH. A. K. Dresher, Worcester, Pa., 557,777. Filed April 24, 1895.
Employs a long and short spring and wedge cams.

ELECTRIC SWITCH. P. E. Marchand, Ottawa, Canada, 557,848. Filed Nov. 2, 1895.
Designed primarily to bring into circuit two or more lines.

Telegraphs:—

AUTOMATIC BATTERY REVERSER. P. Minnis, Mobile, Ala., 557,854. Filed Feb. 17, 1896.
The reversal, whether by accident or otherwise, of a battery at either end of a line, or an intermediate battery, will cause corresponding reversal to take place automatically in all batteries in series with the line.

Telephones:—

TELEPHONY. W. C. and J. M. Lockwood, Brooklyn, N. Y., 557,588. Filed Oct. 29, 1894.
A variable resistance for telephone transmitters, consisting of two flat flexible plates, as diaphragms, with flat electrodes lying thereon, and surrounded by carbon granules.

TESTING APPARATUS FOR MULTIPLE SWITCHBOARDS. C. E. Scribner, Chicago, Ill., 557,708. Filed June 19, 1888.
Provides an induction coil or converter in the circuit of each line so arranged in connection with a generator that an alternating or pulsatory current of low electromotive force shall be normally induced upon each circuit.

TELEPHONE TRANSMITTER. W. L. Wilhelm, Buffalo, N. Y., 557,741. Filed Nov. 21, 1895.
A mouthpiece provided with two branch tubes.

LOCK-OUT SYSTEM FOR TELEPHONE LINES. C. E. Scribner, Chicago, Ill., 557,898. Filed July 22, 1895.
Employs a telephone-switch and two electromagnets.

MULTIPLE SWITCHBOARD FOR TELEPHONE EXCHANGES. M. G. Kellogg, Chicago, Ill., 11,529. Reissued. Filed July 31, 1888.
A metallic circuit subscriber's line normally disconnected from the ground at the subscriber's station, in combination with a calling generator in the circuit of said line at the subscriber's station and a switch co-operating with the normally open ground to close the same while the generator is being operated.

LEGAL NOTES.

A SUIT AS TO FINANCING THE DETROIT ELECTRICAL WORKS.

A special dispatch of March 28 from Detroit says:—Two years ago the Detroit Electrical Works, of which Hugh McMillan was president, became financially embarrassed, and a circular was sent out to the stockholders, many of whom lived in the East, saying that there were only two courses open to them, to submit to foreclosure of a mortgage for $185,000 held by Mr. McMillan, or subscribe more capital. The stockholders were unable to supply the necessary funds, and the works were sold under foreclosure, Mr. McMillan bidding them in for the amount of his claim.

Mr McMillan then entered into a contract with William A. Boland, of Boston, and Frank A. Barnabee, of Providence, to recapitalize the company and enter into a partnership. By the terms of the contract, on the reorganization of the company Mr. McMillan was to receive $200,000 in preferred stock to cover his $185,000 interest in the defunct concern, and was also to receive $350,000 in common stock, which he was to hold in trust for the old stockholders. After making the contract, the Eastern capitalists investigated the affairs of the company, and, finding them unsatisfactory, concluded to stay out.

Mr. McMillan assigned his interest to Louis Warfield, secretary of the company, and William A. Jackson, who brought suit against Boland and Barnabee for breach of contract. The suit was ended in the Wayne Circuit Court this morning, and the jury awarded the plaintiffs a verdict for $283,750. The case will be appealed.

BRUSH STORAGE BATTERY PATENTS SUSTAINED.

A decree has been granted by Judge Colt against the Hopedale Electric Company and Milford & Hopedale Electric Street Railway Company for infringement of the Brush patents now owned by the Electric Storage Battery Company, of Philadelphia. These companies tried some years ago to make a road run with batteries of their own manufacture.

MISCELLANEOUS.

THE DIEHL MFG. CO. AND ITS NEW APPARATUS.

THE new Diehl arc lamp, illustrated in the accompanying engraving, is a clutch wheel lamp and has no dashpot to stick or main magnets to burn out. The clutch is applied to the periphery of the wheel; therefore, the rod is less liable to stick when dirty than is a lamp with clutch working directly on the rod.

The new lamp, Fig. 1, has a striking mechanism that is a positive innovation. This striking magnet is composed of a few turns of course wire placed in the main circuit. When current is turned on the lamp this magnet is energized and pulls the core of the shunt armature down. It holds the core in this position until it is weakened by the arc lengthening, then it releases the core of the shunt magnet and allows it to go up to the feeding point. The armature is then practically out of the field of the striking magnet and the arc depends entirely on the shunt magnets for regulation. This is a most valuable feature, as it does away with the weak point of a shunt lamp, namely, not striking a proper arc when current is turned on.

The adjustable chuck carbon holders take in any size of carbon from ¼ inch to ⅝ inch in diameter. The lamp is claimed to have fewer parts than any other lamp made. All parts are made interchangeable. The lamps are made in a variety of exclusive ornamental designs, and the out-door lamps are made water-proof without the use of a hood.

The Diehl Manufacturing Company, of Elizabethport, N. J., have also just brought out a complete line of dynamos and motors possessing a number of novel features.

The dynamos and motors are of the type shown in the illustration, Fig. 2, which shows the machine direct connected to a Case engine. This installation is on board the boat "Reverie."

The principle on which these machines are constructed is that of the armature encircling and revolving around the field magnets; this gives high efficiency combined with the slowest speed, insuring greatest durability, and dispensing with the necessity of countershafting, and the waste of power incident thereto. This slower speed, being due to the large diameter of the armature, is obtained without increase of weight and gives a starting torque proportionately great, at the same time increasing the efficiency by a diminution of friction of the bearings and the brushes.

The motors are fitted with self-aligning and self-oiling bearings and approved brush holders, thereby requiring a minimum of attention. The standard motors of 2 horse-power and under are bipolar; 3 horse-power and above are multipolar.

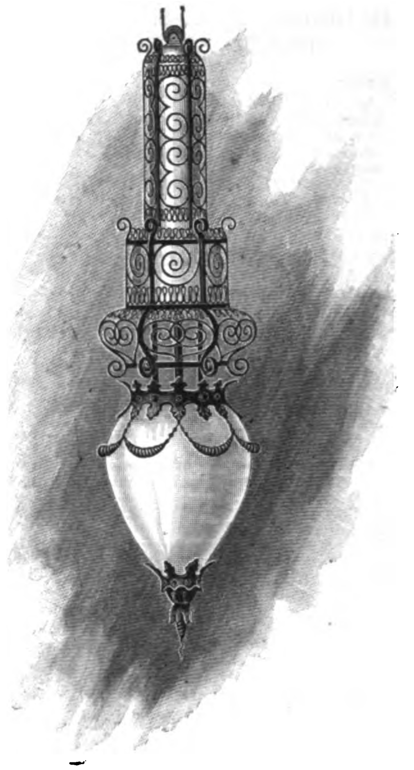


FIG. 1.—NEW DIEHL-KNIGHT ARC LAMP.

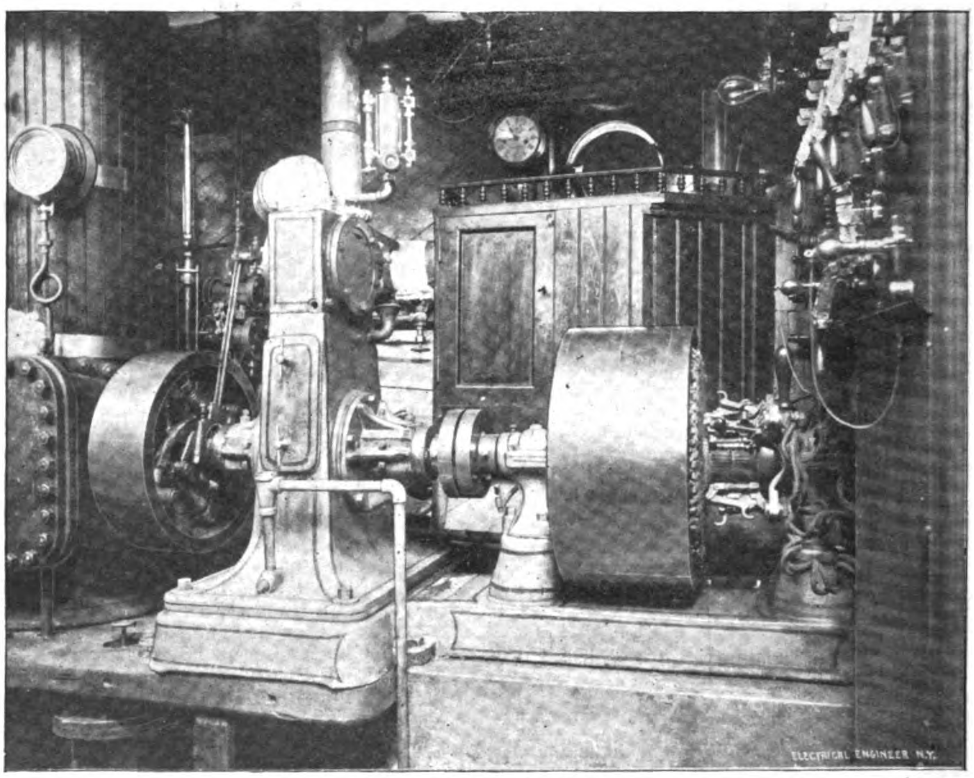


FIG. 2.—DIEHL DYNAMO DIRECT CONNECTED TO CASE ENGINE, ON BOARD THE "REVERIE."

In addition to their standard motors the Diehl Company are prepared to furnish estimates on motors for direct connection to special machinery.

Another unique product of the company is the Diehl electric balance wheel motor as applied to the shaft of sewing ma-

chines. The motor is entirely self-contained, and the field magnets are fastened to the arm of the machine. The armature carrier acts as a balance wheel, and is secured to the shaft by means of the regular clamp stop motion, thus allowing the release of the machine when used for winding bobbins. The combination takes up very little more space than the ordinary balance-wheel.

The speed is kept under perfect control by means of a small brake and rheostat operated by the treadle. The motor is constructed with as much care as the larger ones, and the finish adds much to the general appearance of the machine. This design of motor is manufactured in two sizes, one for family use and one for manufacturing.

The Diehl Manufacturing Company, which is manufacturing this apparatus, and which has its factory at Elizabethport, N. J., is a strong organization. It takes over the old business of the Diehl Company, whose ingenious apparatus is chiefly, if not wholly, the design of the clever inventor, Mr. Philip Diehl, mechanician of the Singer Sewing Machine Works, who is well known to all our readers. Hitherto the company has not built any generators larger than 20 horse-power, but it will now make all sizes up to 100 horse-power for all purposes of light and power, its specialty being direct coupled generators. It will also turn out large quantities of its ceiling and propeller fans, in which field it was a pioneer, and it will also manufacture its novel balance wheel motor, its arc lamp, and other meritorious specialties. It has greatly increased its facilities and has added a fine outfit of the latest machinery and tools. Some idea of the scope of its operations may be formed when we state that there are already over 11,000 of its suspended electric fans in use.

The president of the Diehl Manufacturing Company is E. H. Bennett, Jr.; vice-president, Philip Diehl; secretary, H. S. Miller, and treasurer, J. A. Reid. Mr. John C. Knight, well known as an arc lamp inventor, will be in charge of that important department, which will produce lamps of his latest design. The selling office at 561 Broadway, New York, will be in charge of Mr. B. C. Kenyon, as manager of sales, and Mr. C. A. Bramhall will be its representative. Mr. M. T. Lindenburg will be in charge of the Boston offices at 128 Essex street. The agencies will be as follows: Philadelphia, Vallee Bros.; Texas, Waco Electric Supply and Cons. Company; New Orleans, Southern Electric Manufacturing and Supply Co.; Birmingham, Ala., Harris & Wilkenson; Indiana, Frank J. Fox, Indianapolis; Richmond, Va., A. Pizzini, Jr., Norfolk, Va., J. L. Belote; Wilmington, Del., C. R. Van Trump. Other agencies are rapidly being established, and the company looks forward to doing a large business.

THE CENTRAL UNION TELEPHONE BOND ISSUE.

Speaking of the proposed issuance of $1,600,000 twenty year bonds at 6 per cent. by the Central Union Telephone Company, the "Chicago Record" says:—These are offered pro rata to stockholders at 97½. This bond issue was made necessary by the competition which the Central Union Company has encountered during the last fifteen months. The exchanges of the company are almost all in small towns, where competition is easy. The expiration of patents and recent inventions have put many telephone companies in the field, and the auxiliary Bell concerns, which once enjoyed a monopoly on the industry in their various districts, are now obliged to lower their tariffs and sometimes practically furnish service free in order to exist.

This condition of things has obtained in several towns in which the Central Union Company operates, and the statement for 1895 showed net earnings of $355,165, against $405,988 in 1894. In 1895 also a floating indebtedness of about $800,000 was accumulated. With new bonds it is proposed to wipe out this debt, to make extensions into new territory and prepare against competition by furnishing the best service obtainable. In Indianapolis and Columbus it is necessary to put many wires under ground. It is believed that good return will be received from extensions planned, although many are aware that the telephone industry in the smaller cities and towns of this country is just now in a precarious state. In a large city the conditions are very different, for the magnitude of the exchange is a guaranty against competition and the best assurance of the continuation of a monopoly. A large portion of the floating indebtedness is owed to the Bell Telephone Company, and it is said this corporation is willing to accept bonds at 97½ in settlement of its claim.

The authorized capital stock of the Central Union Company is $10,000,000, of which $6,605,300 is now outstanding. No bonds have been issued. The company controls the Bell patents in Indiana and Illinois excepting five counties, in Ohio excepting Cleveland and Cincinnati and in Des Moines, Davenport, Dubuque, Cedar Rapids, Keokuk and Ottumwa, Iowa. The company pays dividends of 5 per cent.

Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

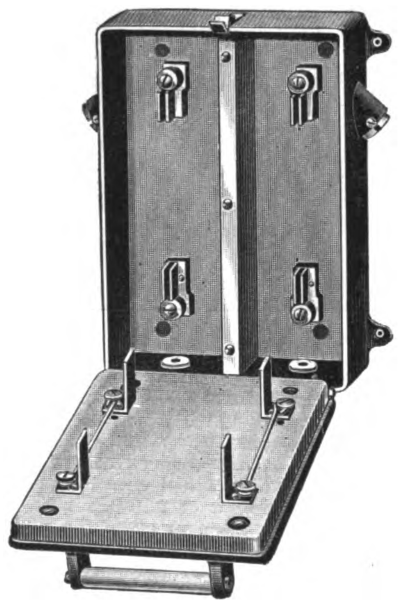
KOKOMO TELEPHONE APPARATUS FOR GRAND RAPIDS MICH.

We note the following from the Grand Rapids "Democrat": "After a long, exhaustive contest the Executive Committee of the Citizens' Telephone Company last night awarded the contract for 1,800 telephones to the American Electric and Telephone Company, of Kokomo, Ind. The contest has waged almost continuously for the past four weeks, with representatives of a dozen of the largest telephone makers in the country in attendance. Messrs. Fisher and Ware, of the Citizens' Company, were desirous of obtaining the best instruments to be had and it was largely due to their caution in this regard that the awarding of the contract was so long delayed. The machines selected embrace the full long-distance equipment and every modern improvement. General Manager P. C. Burns and Special Agent S. J. Bear signed the contract in behalf of the Kokomo concern. Shipping of the 'phones will begin in about two weeks and it is expected that the new exchange will be ready to respond with the familiar "number, please," about April 15. The 1,500 subscribers already secured cannot, however, all be supplied before May 1. The contract placed last night is the largest ever awarded by an independent exchange in America and represents a cash outlay of nearly $35,000. The Kokomo Company is also supplying the switchboard equipment."

THE BRYANT HIGH-TENSION SERVICE SWITCH AND CUT-OUT.

Encased in an iron box lined with slate thoroughly impregnated with oil and absolutely moisture-proof, this high tension switch makes the most perfect combination for 500 and 1,000-volt service cut-out. The principle observed in the well-known K. W. cut-outs, namely, fuses placed in the cover, forms one of the valuable features in this new device offered to the central station manager.

This service box is in reality a 100-ampere double pole, double break switch, with cut-out combined, with the further advantage of being entirely inclosed and protected when the current is on.



BRYANT HIGH TENSION SERVICE SWITCH.

To insert the fuses, the cover is opened, and the clips, between which the fuses are to be placed, become dead, and the operation is attended with no danger.

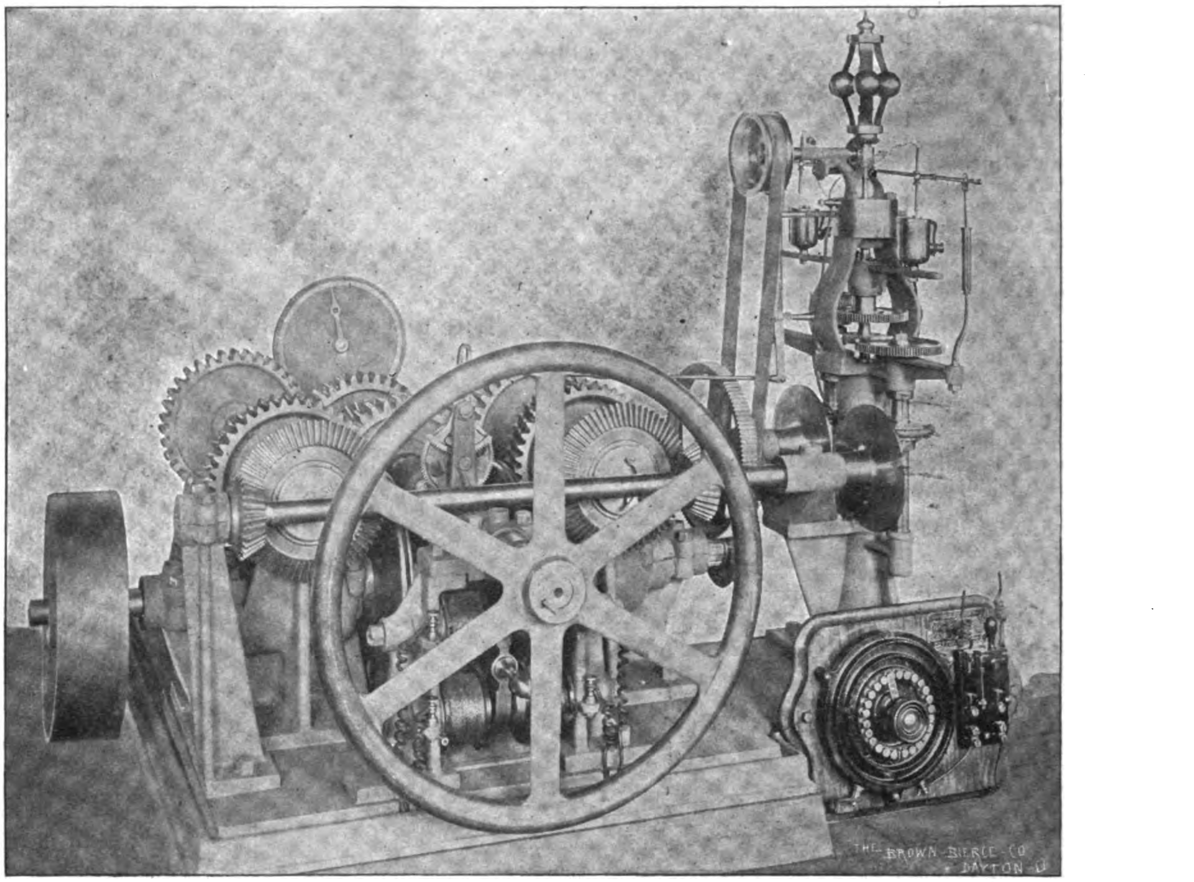
The switch is adapted not only for the primary side of alternating circuits, but equally well for 500-volt motor circuits.

The box has been approved by the fire underwriters. The Bryant Electric Co., of Bridgeport, are now prepared to deliver these switches.

THE GIESLER ELECTRO-MECHANICAL WATER-WHEEL GOVERNOR.

THE Stilwell-Bierce & Smith-Vaile Company, of Dayton, O., have realized for a long time that no governing device for water-wheels brought out up to this time was at all adequate to take care of the sudden and material changes in load and maintain a uniform speed. Formerly a variation of speed of 5 to 10 per cent. was permissible in ordinary mills. Now, with electric generators, a variation of not exceeding 1 per cent. is desired. During earlier experiments, efforts were directed to making a governor entirely electrical, that is, one which should use the change in the electrical current as a medium for governing the water-wheel employed in generating that current; but the results were unsatisfactory. Very fair results were obtained by the use of a hydraulic piston, but there were objections to this form in actual practice, and they were expensive to build and maintain as well.

After experimenting in every direction, they finally settled to the conviction that the form adopted and as shown in the accompanying cut was decidedly the most desirable in every way. With this machine, the slightest variation in speed is instantly multiplied to any desired extent, and enables them to open or close the water-wheel gate long before the ordinary balls would show any sign of moving. The governor can be arranged so as to fully open or close the water-wheel gate in from three to fifteen seconds, according to the requirements of the situation. The makers are enabled to use very small balls in this governor, because the balls are relieved of doing any work whatever. These balls and their attachments are all balanced to the finest degree possible, and their movements magnified to such an extent that the slightest variation in centrifugal action will at once manifest itself by directly opening or closing the water-wheel gate as required.



THE GIESLER ELECTRO-MECHANICAL WATER WHEEL GOVERNOR.

THE EXCELSIOR ELECTRIC COMPANY have moved back to the Boreel Building, on Broadway. It seems like old times to find them there again. President Fuller and his associates have the best wishes of the trade for another period of prosperity and for the sale of more than ever of their excellent generators, motors, platers, depositing dynamos and lamps.

NEW OFFICES OF THE STANDARD PAINT CO.

THE Standard Paint Company, the well-known manufacturers of P. & B. Paint, and the sole selling agents in the United States for Ship carbons, manufactured by Messrs. Schiff, Jordan & Co., of Vienna, have this week moved into much more commodious quarters at Nos. 81-83 John street, New York City.

For some time past the Standard Paint Company have felt that their past quarters were much too small for the prompt conduct of their business, and have now moved into new quarters on John street, which will give them a great deal more room for the transaction of their rapidly growing business.

On the first floor are stored samples of their P. & B. paints and paper, and in the back are the general offices for the transaction of their regular business. Mr. F. S. De Ronde, who has been associated with this company for many years, has his private office on this floor, and takes entire management of the sales department, both of the P. & B. goods and the carbon department. One flight up Mr. Shainwald has a handsome suite of private offices, and has fitted them up in a very handsome and attractive manner.

Behind these private offices are two departments divided off by railings, which formed a prominent feature of their exhibit at the World's Fair some years ago; and in one of these will be found Mr. Vandewater, well known to all newspaper men as a designer of the many attractive advertisements which the Standard Paint Company are in the habit of using.

The Standard Paint Company are to be congratulated on the necessity for finding these much more commodious quarters and on their selection of such a convenient and well-arranged office and store.

SALE OF THE BAXTER MOTOR WORKS.

The Baxter Electric Motor Works, Baltimore, have been purchased by Mr. Benjamin F. Deford for $25,000. Mr. Deford made the purchase as the representative of the bondholders' committee of the property. It has not been determined what disposition of the works will be made. A meeting of the bondholders will be held next week to consider the subject.

FIREPROOF LIGHTING AND STREET RAILWAY STATIONS.

FIRE in an electric generating plant is most destructive. In nine cases out of ten the cost of the equipment is ten times the cost of the building, and in case of fire the machinery is generally ruined beyond repair. The building is but a small per cent. of the total outlay. For a very small extra expense, these buildings can be made absolutely fireproof. The internal arrangement requires little or no wooden fixtures. If the walls are made of brick, and wood is eliminated from the roof, the plant becomes absolutely fireproof, for the reason that there is nothing about the construction to burn. Nothing, we may say, is fireproof, but if a plant is so constructed that there is nothing about it to burn, why is it necessary to carry any insurance? Corrugated iron will condense moisture on the underside, and, therefore, many power plants are built with steel trusses, covered with plank and slate. The Berlin Iron Bridge Company, of East Berlin, Conn., however, are able to build a roof for power plants made of corrugated iron covering, which will not drip from the underside in extremes of temperature. This construction has not a particle of woodwork about it. There are a large number of these stations now in use, all giving entire satisfaction. Parties contemplating work of this kind would do well to communicate with the Berlin Iron Bridge Company in this matter.

THE BELKNAP-CHAPMAN AUTOMATIC CONSTANT POTENTIAL REGULATOR.

FOR many applications of electricity a constant potential is an imperative necessity. The operation of a plant of incandescent lamps is a case in point. All the difference between financial success and failure of a plant may frequently be traced to good or bad regulation at the generators. A variation of only a small per cent makes an enormous difference in the life of the lamps.

The operation of most systems of power transmission also demands constant potential to be maintained at some part of the system and it is not infrequent to find in the power stations of to-day a man constantly employed watching the voltmeter and making hand regulation to counteract the changes that are constantly occurring. The compound winding of the generator does not remove the difficulty. A change of speed changes the voltage, the compounding does not compensate for that, and furthermore if the speed is constant and the compounding is therefore supposed to secure perfect regulation there is sometimes a considerable discrepancy, owing to two different causes. One of these is the change of temperature of the coils and the other is the hysteretic quality of the iron of the field magnet.

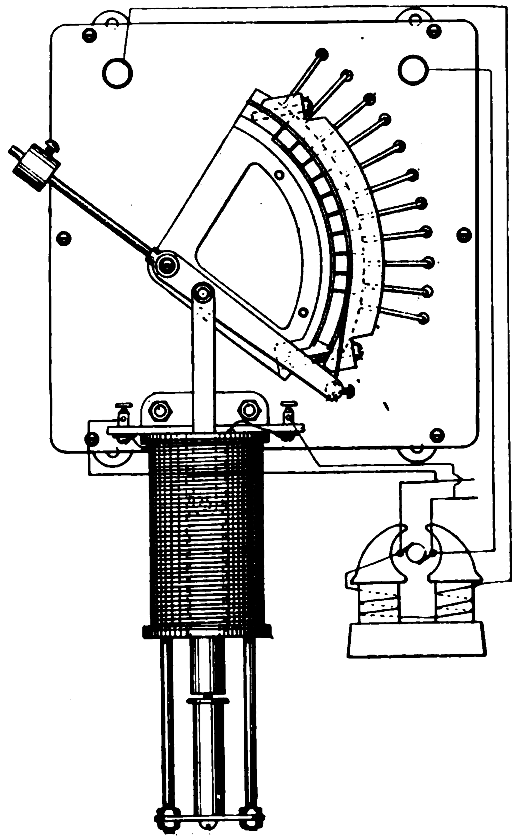
A generator running at exactly its normal speed and normal load may at one time develop a voltage higher than the normal and at another time a voltage lower than the normal according as the conditions of load have previously been higher or lower. The best of generators give a higher voltage when running on the strong side of the hysteresis loop than when running on the weak side, and no compounding can remedy the difficulty.

A perfect automatic regulation can only be secured by something outside of the machine itself, and recognizing this fact the Belknap Motor Company, of Portland, Me., have brought out a regulator which is shown in the accompanying engraving and one which is meeting with unqualified success both on account of its effectiveness and its extreme simplicity.

The invention originated with W. H. Chapman, the company's electrician, in connection with a lighting plant operated by water power at Bar Mills, Me. The water-wheel had no governor and the changes of load were such as to cause the speed at the dynamo to vary from 900 to 1,400 r. p. m. when no change was made at the water-wheel gate. The regulator shown was devised and applied with perfect success and in spite of these extreme variations in speed, the potential is kept within 1½ volts of the required point on the 110-volt circuit.

The device consists essentially of a field rheostat and a solenoid to operate it. The resistance coils are mounted on mica covered pipes placed inside of an iron box with slate front. On the front of the box is mounted a series of contact segments connected to the resistance coils and arranged in the arc of a circle, at the center of which is pivoted a lever. One arm of the lever carries a stud and contact brush that moves over the peripheral surface of the segments. The other arm of the lever carries an adjustable weight, by which the voltage may be adjusted to any desired point, and the regulator will then keep it at that point. The resistance is connected into the shunt field circuit and the contact brush short circuits more or less of it, according to its position.

The solenoid that operates the lever arm is built large, so as to make the friction of the moving parts enter as a small factor of the total power of the solenoid, and the solenoid and its core are of such proportions that the lifting force through a range of a couple of inches is almost exactly constant. A solenoid constructed to expend 55 watts is found to operate this style of rheostat on changes of 2 per cent. in voltage, and larger solenoids operate with greater accuracy. The solenoid



THE BELKNAP-CHAPMAN CONSTANT POTENTIAL DYNAMO REGULATOR.

is connected as a shunt to the armature circuit, and may be connected to the potential wires that lead to some distant point of the system, and the apparatus then makes allowance for the loss in the line, and secures all the benefits of an overcompounded generator run at absolutely steady speed, even though it actually be attached to a plain shunt machine and that machine be run at a speed varying 50 per cent. or more.

This method of regulating is not only adapted as a perfect supplement to the compound winding, but also to entirely displace it.

FERRACUTE MACHINE CO.

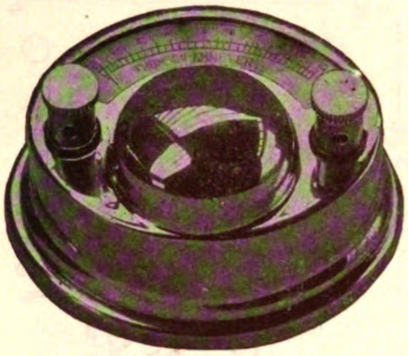
The Ferracute Machine Company, of Bridgeton, New Jersey, manufacturers of presses and dies and other sheet-metal tools, make a number of presses which are especially adapted for the electrical trade. They build several open front presses for cutting armature discs up to 20 inches diameter, as well as a number of round and square bed double-crank presses for large discs. This is the best form of press, it is said, for cutting circles for armature discs and for sections of large discs. This style of press seems very popular, the General Electric Company having seven of them, while several other firms are using them for electrical work.

They will be glad to give information about their armature disc cutting press for notching armatures from 3 inches to 36 inches diameter. They also make a number of sizes of punching presses for cutting out instruments and other work in heavy metals, which have proved popular for the electrical trade. They will exhibit at the Electrical Exposition in May, in New York, three or four of their presses, and will probably have them running with electric motors, manufacturing small articles.

They issue a handsome catalogue describing some 300 different presses; also a new sheet devoted to presses for special work, which they will be glad to send on application.

NEW G. E. POCKET AMMETER AND VOLTMETER.

THE introduction by the General Electric Company of the new measuring and testing instruments for alternating current work (described in our issue of March 25) has been followed by a development no less valuable along similar lines, and a set of ammeters and voltmeters has been especially designed for carriage in the side pocket of an ordinary coat. They are known as the Thomson pocket ammeter and pocket voltmeter. These pocket instruments give to the isolated plant engineer, the manager of the small central station and



NEW G. E. POCKET AMMETER.

the working electrician a cheap and reliable instrument which may be carried in the pocket and exposed to comparatively rough usage without the fear of impairment of accuracy.

The construction of these pocket instruments while suited to meet the different usage to which they are likely to be subjected, is similar in principle to that of the standard instruments. They are oval in shape, 4¼ inches by 3½ inches. Notwithstanding the singular compactness of the pocket instruments the scales are unusually long and clear. They are completely encased by a polished nickel cover. The ammeters are calibrated to read, 2, 10, 25 amperes, the voltmeters read from 0 to 75 and 150 amperes.

SPRING SUNBEAMS.

The Sunbeam Incandescent Lamp Company, Chicago, have received the following letter from the Wheaton Electric Light and Water Company, Wheaton, Ill.: "We have now several hundred of your 4 c.-p. lamps in use. They give as much light as an ordinary kerosene lamp and with them we have been able to displace kerosene in a number of places and also to retain some of our old customers that we otherwise would have lost. They are a success in every way and give us the best satisfaction."

CROWN WOVEN WIRE BRUSH CO.

Owing to increasing business, the Crown Woven Wire Brush Co., of Salem, Mass., have moved into the new Power's Block, near the B. & M. Railroad station, where they have a model factory, and hope to turn out even better goods than heretofore. The growth of this company's business is phenomenal, and is one of the results of making honest goods. Their Crown "K" brush, in particular, is meeting with great success. They are not only selling their brushes in the United States, but are sending them to Mexico and Canada, and hope soon to place them on the English market. Their new factory, which is especially adapted to their business, will enable them, not only to turn out brushes in larger quantities, but to compete with any goods in the world in quality or price.

"IN TIME OF DRIFTS PREPARE FOR DRAFTS."

The Electric Appliance Company have closed arrangements for the agency for the Dayton Electric Ceiling Fan, and have a complete line of these fans in operation at their salesrooms at 242 Madison street, Chicago. The Dayton Company make a very attractive line of these goods, including a handsome electrolier and column fan. Some of the special points claimed for the Dayton fans, aside from their artistic finish, are that they have four blades, run at a high speed, and have a very high efficiency.

NEW BRITAIN, CONN.—During a fire at the Russell & Erwin Mfg. Works, the flames were entirely prevented from spreading from one department to another, by the corrugated iron doors that were furnished by the Berlin Iron Bridge Co.

SOME REMARKABLE CARBON BRUSHES.

The Partridge Carbon Company, of Sandusky, O., have received the subjoined letter as to some of their carbon brushes that had run 50,000 miles. They had worn down only about three-quarters of an inch, very evenly and smoothly:

Point Pleasant, Mich, March 26, 1896.

Partridge Carbon Company, Sandusky, O.

Gentlemen: I send you to-day two motor brushes made by you and bought by us from Westinghouse Electric and Manufacturing Company, during July, 1894. These two brushes have been in use seven months, during which time the car from which brushes were taken, has made a mileage of about 48,000 to 50,000. The brushes sent are about the worst worn of a set of ten that I have in my possession. To me this is something extraordinary, as I have had the experience of seeing new carbon brushes put on motors every other night.

We are using Westinghouse No. 12, 20-horse-power motors. I would say that I originally bought 100 brushes and I have them all now, none having been used except the ten, as above, which are good for another 50,000 miles' run. I do not think there is another such brush on earth as the Partridge for long life, wear on commutator, etc.

I believe in showing appreciation of a good thing, hence my letter. Very truly yours,

SOUTH JERSEY STREET RAILWAY COMPANY,
Per P. T.

N. B.—Would say that our line runs along beach front, where sand and dust are in plenty.

NEW ENGLAND NOTES.

THE ANCHOR ELECTRIC COMPANY, 71 Federal street, Boston, report having closed recently their fiscal year. It was a year that on the whole was highly successful and far better than had been expected, leaving the current prospects admirable and very bright. The company have been enabled to declare a satisfactory dividend, besides laying by a good sum to reserve.

THE BEACON ELECTRIC COMPANY, of Boston, through the efforts of Mr. E. McOuat, their superintendent, have been making rapid progress with the manufacture of Crookes tubes and have already produced a large number in various designs, which have proved very successful. They are also now making a specialty of miniature incandescent lamps and series lamps, and have sold a large number of regular 16 c. p. lamps, with fleur-de-lis embossed on an opal glass, which gives a very pretty effect.

MEXICO CITY.—Mr. J. E. Torbet, of the Mexican Electric Company, has been appointed General Mexican Agent of the Beacon Lamp Company, of Boston, Mass., the Bryant Electric Company, of Bridgeport, Conn., and the American Electrical Works, of Providence, R. I. A full line of goods from these factories will be carried in stock at the offices and salesrooms.

WESTERN NOTES.

THE AMERICAN BATTERY CO., West Quincy street, Chicago, report that their business is still steadily growing, and that from the present outlook there is every sign of the increase in their output continuing at its present healthy rate. The American Company's batteries are well known through the country for giving most satisfactory results for lighting and other purposes where storage batteries are used. Amongst some of the recent contracts which they have closed was one with Gen. Joseph Torrence for sixty 600-ampere hour cells for lighting his private residence on the Lake Shore Drive, Chicago.

THE REITH ELECTRIC COMPANY has been formed at Chicago by R. D. Rowe, P. Reith and J. M. McNable, with a capital stock of $4,500.

THE ELECTRIC APPLIANCE COMPANY have just completed the successful installation of an electric light and power plant in their own building at 242 Madison street. The power is secured from a powerful natural gas engine, which also does the work of driving a large freight elevator. The plant is running nicely and producing a satisfactory light. The dynamo is assisted in accomplishing its results by the use of Paranite wire and Packard lamps. The switch-board is equipped with C. E. N. jack-knife switches and Whitney instruments.

BOWERS & BROS., Lake street, Chicago, have forwarded us a copy of their useful, new price list of cut and uncut India and amber mica, and of Billings & Spencer drop forged copper segments for dynamos and motors. It is comprehensive and gives full data.

Department News Items will be found in advertising pages.

THE
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Power Transmission.

ELECTRIC POWER IN BRICK YARD AND FOUNDRY.

BY F. M. TAIT.

ABOUT eight months ago the writer induced the Lehigh Fire Brick Company, of Catasauqua, Pa., to change over from steam to electric power, pointing out the great economy and superior advantages to be accomplished by throwing out their 65 horse-power engine and long line of shafting then in use. This has been fully demonstrated since the new plant has been in operation.

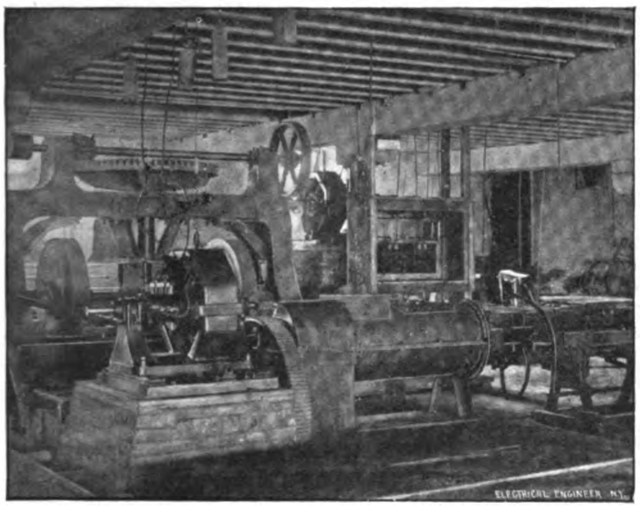
A 40 horse-power multipolar, 220-volt motor drives a 9-inch circular pan by means of gear wheel and pinion, as shown in the engraving Fig. 1. Suspended over the pan, but not touching it, are two heavy steel-tired wheels weighing 4,500 lbs. each. These wheels turn freely on shafts whose ends are free to slide up and down guide ways, thus allowing the wheels to be adjusted to any height above the pan desired, according to the fiber needed in finished brick.

The contents of small wooden cars carrying a mixture of brickbats, spar, fireclays, etc., in proper proportions, is dumped into the pan while it is in motion, carrying the raw materials under the heavy wheels, which commence to roll upon their shafts and mash down the mixture every time it comes around. Plough-shaped pieces properly set at various places in the pan, but not touching it, guide the mixture always under the wheels. Water is mixed with the materials in the pan from time to time until it resembles stiff mud. After being worked about in the pan for four or five minutes and proving properly tempered it is shoveled into the molding machine, shown in the foreground. A 25 horse-power, 220-volt motor of same type as the other drives the shaft of this moulding machine through gear and spur wheel, as shown.

On the shaft of this moulder are, arranged propeller-like blades, which revolve within the hollow cylinder and always force a continuous slab of fireclay through an opening at one end, called the die. This is cut off every four feet by one stroke of a lever, carrying a piece of piano wire, stretched taut, for a knife. Another lever forces the detached slab of tempered or finished fireclay against wires set vertically in a frame the exact distance apart required for finished brick, this operation making from nine to twelve brick, according to size. The cutting table is shown near the die on the moulder.

The bricks are then placed on a continuous running elevator, belted to the tempering pan shaft, and carried upstairs to the drying room, whence they go to the burning kilns. These kilns are fired by coal, using forced draft from a No. 6 Sturtevant blower direct connected to a 10 horse-power, 220-volt, electric motor at 1,250 r. p. m.

This arrangement shuts off the entire steam consumption in this plant, except in winter time, when a small boiler maintains ten to twelve pounds pressure for heating the buildings and drying brick. The economy and increased output of this plant is remarkable and interesting, from the fact that the motors are located 6,000 feet from bus-rods in our central station and have but 220 volts on 3-wire Edison circuits available for pressure. A polished slate switchboard, with main line switch, fuses and recording wattmeter mounted thereon, is placed in the office of the brick company and controls the wires entering the building to various motors. This arrangement allows the manager to tell at a glance what his power costs him to manufacture one brick, greatly facilitating close figuring, so necessary in these days of keen competition.



Electric Power in a Brickyard. (Crocker-Wheeler Installations.) Electric Power in an Iron Foundry.

I believe this is the first plant in the country manufacturing fire brick successfully by electricity.

Another plant, also installed by the writer, and interesting from the fact that it has effected great economy, was the installation of a 10 horse-power, 220-volt, electric motor to a drum arrangement for drawing cars heavily loaded with pig iron, coal, coke, etc., up an incline to charge the foundry cupolas in the well-known foundry and machine works of the Davies & Thomas Company, East Catasauqua, Pa. This motor is direct connected through a worm gear, and draws cars up a 12 per cent. grade with ease 120 feet per minute. The engraving, Fig. 2, shows a car with three tons of iron, outside of weight of car, ascending the slope to the cupola doors.

The cupola man operates this motor from the top by means of a street-railway controller. Conveniently placed near it is a lever for throwing in a clutch which connects the drum with the shaft of the gear wheel. Another lever controls a band friction brake around the edge of the drum and allows the empty cars to be run down the incline by gravity, first throwing out the clutch. As the current consumed is but for a few seconds while ascending, it is obvious the expense of

operating this motor is nominal. All current passes through a wattmeter conveniently located in the office of the iron company.

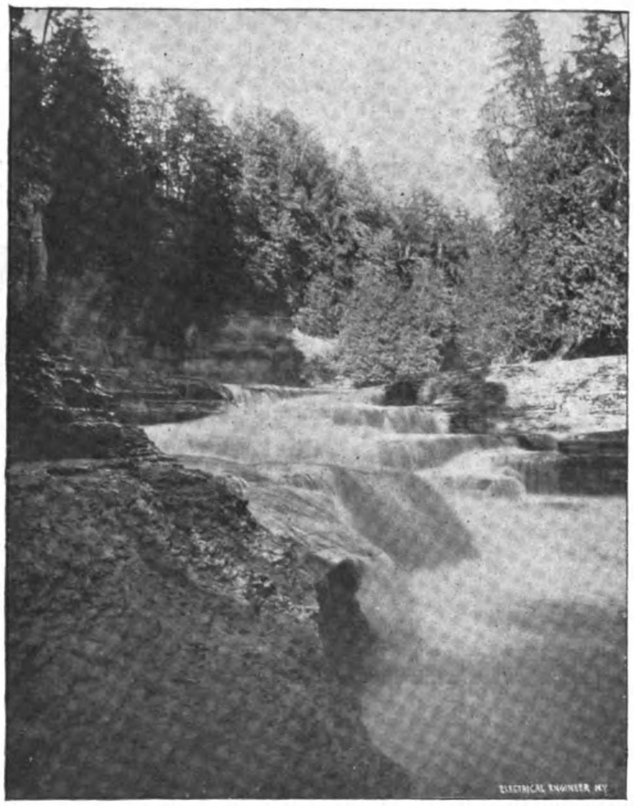
The raw materials previous to the installation of this motor were wheeled in barrows and small cars to the cupolas. The motor is snugly out of the way boxed in under the track and receives but little attention. It has been in daily operation almost one year. There are many other motor applications here, as usually found elsewhere, from that of clipping and cleaning horses to making ice cream, churning butter, etc.

THE TRENTON FALLS AND PROSPECT WATER POWER DEVELOPMENT.

BY ORRIN E. DUNLAP.

THE City of Utica and surrounding neighborhood seem very likely to be largely benefited by the development of the water power of the West Canada Creek at Prospect and Trenton Falls. The West Canada Creek has its source in the Adirondacks to the east of the villages of Prospect and Trenton Falls. It flows west, passing somewhat to the south of the village of Prospect, then makes a turn nearly at a right angle, flowing south to the Mohawk River, of which it is the principal tributary at Herkimer. The principal and most remote source of this stream is the group of lakes about forty miles northeast of Prospect, known as the West Canada lakes.

The power scheme projected is one of the most notable in the eastern part of New York State. From the fact that the



THE TRENTON FALLS.

forests surrounding the source of water supply are assured of preservation, and the locality surrounding the proposed points of power development is rich in markets for the power product, there seems every incentive to investment on the part of capital. The watershed is of the highest portion of the Adirondack wilderness, about 175 miles square, and has more than sixty lakes, having a total area of twelve square miles. The lowest of the lakes stands at an elevation of about 2,300 feet above the sea level and the lowest portion of the watershed is about 750 feet above the streets of Utica. It is from these lakes that the West Canada Creek flows for about forty miles, receiving along its source water through various tributaries. The largest of the lakes is the Honedega, formerly known as Jock's Lake. Near Prospect, as stated, the creek takes a sharp turn and flows nearly south for a distance of two and one-half miles, and on this part of its course there is a fall of nearly 500 feet. Further on down stream a mill utilizes the power from a portion of a fall, and from this point on to the Mohawk there is a fall of about 250 feet distributed along its course.

In response to a desire of capitalists, Mr. Wallace C. Johnson, M. Am. Soc. C. E., of Niagara Falls, has made a most thorough and careful study of the West Canada Creek locality and its power possibilities, and he has formulated a report most flattering to the project. Mr. Johnson is especially well qualified to consider such a subject in its entirety and with accuracy from the fact that he has had extended experience in hydraulic power matters and is at present the engineer of the Niagara Falls Hydraulic Power and Manufacturing Company.

In his extended report Mr. Johnson reviews the available rainfall statistics of the section and reaches the conclusion that at least two-thirds of the downpour eventually would, in such a thickly wooded section, reach the stream. This, he states, would produce a mean flow, in the average year, of 904.6 cubic feet per second. He finds that 1895 was the driest year in seventy years, and in that year Professor Scripture made a series of measurements at Morgan's mill, which is at the lower end of the 500-foot drop at Trenton Falls, and Mr. Johnson has calculated that in that dry season there was a flow of 357 cubic feet per second, or a little less than one-half the amount he estimates as the mean flow.

He concludes, therefore, that to be sure of maintaining the mean flow during the driest years, they must provide for an addition to the dry weather flow, at periods of lowest water, of a quantity equal to 390 cubic feet per second. This could be done by building a reservoir having a capacity of two thousand million cubic feet, which storage could be provided very cheaply in the watershed by placing low dams at the outlets to the several larger lakes and deepening the outlet so that the water can be drained a few feet below the present level.

For instance, he cites the case of Honedega Lake, stating that if a dam were placed at the outlet of that lake that would raise the water five feet and the outlet deepened so as to drain five feet below the present level, this lake alone would provide one-fourth of the amount needed. The raising of the lake levels would work no injury to the timber or other interests, but all the mills on the creek below the water power and all the mills on the Mohawk below the mouth of West Canada Creek would be benefited. The expense would have to be borne by the milling interest. It is Mr. Johnson's opinion that the Erie Canal could be conveniently fed from West Canada Creek.

Plan of Development.—Of the general plan of development and amount of available horse-power, Mr. Johnson says: "There is said to be a total fall in the stream, between Prospect and Trenton Falls, of about 500 feet. If the mean flow of the stream in dry years (740 cubic feet per second) were used under a head of 500 feet, it would be sufficient to develop upwards of 25,000 horse-power. In order that the supply of water to the wheels may be perfectly steady and reliable, it is necessary that the sufficient pondage be obtained below any mills which may be built to guard against any temporary checking of the flow of the streams by the acts of the mills above. It has been decided by the courts that the users of power from a stream have the right to retain the flow sufficient for its full use in their business, but not to a greater extent. The lack of railroad facilities and the general character of the country about Prospect preclude the idea of the establishment of any very great factories on the West Canada Creek above this point. A few sawmills have already been built and other industries of that character may in the future use the waters of this stream. The damming of the stream and the use of its waters for these purposes might stop or check its flow for a few hours; hence the necessity for a certain amount of pondage.

"An effective working head of ninety-five feet is all that can be depended upon. Seven hundred and forty cubic feet per second used under a head of ninety-five feet is sufficient to produce 6,400 horse-power, that is, 6,400 real and effective horse-power, on the shaft of the water wheels. This amount of power is sufficient to drive generating machinery having an output of electric energy equal to 6,000 horse-power. Power can be transmitted to the City of Utica with a loss not exceeding 10 per cent., which would give at the central station in the city an amount of electric energy equal to 5,400 horse-power.

"In designing the dam, canal and power house, I have kept in mind the fact that at some time in the future the additional rights controlling an additional head of 400 feet will probably be secured. The canal and the dam are located in the proper place for this larger development and would be used without any changes.

"The West Canada Creek, flowing as it does through a deep gorge, has not afforded an advantageous place for the building of mills, to use the power of the wheels directly. The

means of transportation, too, have been very limited. Within the past few years the transportation facilities have considerably improved by the building of the Adirondack branch of the New York Central and Hudson River Railroad, and the vicinity of the West Canada Creek, along some parts of the two and one-half miles of its course, within which the 500-foot fall occurs, now affords desirable sites for new factories. which could be supplied with power conveyed to their works by electricity, when the full 500-foot fall may be utilized. For the first development, which is herein particularly planned and estimated upon, a surer and more profitable field can be had than the supplying of factories, which might be induced to locate in this region."

Mr. Johnson then enumerates the power required by the electric light, railway and other local industries in Utica as showing the market available. In concluding his report, Mr. Johnson reviews the revenue to be expected.

The proposed method of development would be along lines similar to the plan of the Niagara Falls Hydraulic Power and Manufacturing Company. All masonry is to be of Trenton limestone. The gates of the head and the section of the canal are to be of proper size to carry 740 cubic feet of water per second with not more than one foot loss of head when the pond is three feet below the crest.

From the canal the water will be conducted to and along the power house, which will be one-story high, in two penstocks eight feet in diameter. To each penstock it is proposed to connect five turbine wheels of a capacity of 800 horse-power each, running on horizontal shafts. The floor of the power station, on which the wheels will stand, will be about twelve feet above the water level to be beyond the water at flood time. Draft tubes will be used to secure the remainder of the head. All generators will be direct coupled to the shafts of the turbines. The capacity will be such that one turbine and one generator of each set of five may remain idle for repairs or examination.

For a plant that could be quickly installed to light the City of Utica, Mr. Johnson recommends the use of three upright water wheels of 500 horse-power each geared to the same shafting connected to three generators, each of 350 kilowatts, and a line to deliver in Utica, fourteen miles distant, 850 horse-power; the pole line thus established to carry the line for heavier transmission when it is available.

A 21-MILE MUNICIPAL TRANSMISSION, RIVERSIDE, CAL.

THE California Electrical Works, San Francisco, have received the contract for the municipal lighting plant for the city of Riverside, but as yet the construction of same has not been commenced. They expect to commence the construction about May 10. The contract is for a transmission plant of twenty-one miles, the power plant being located on Mill Creek, about eight miles from Redlands, in San Bernardino County, and the city of Riverside rents its power from the Redlands Electric Light and Power Company, paying $3 per month per horse power, delivered at the sub-station in Riverside.

The Redlands Electric Light and Power Company have had their generators installed for nearly two years, but at the generating station will now be placed three 100-kilowatt step-up transformers, to raise the potential from 2,500 to 11,000 volts. There will be also a marble switchboard for 10,000 volts placed in the power station. The transmission line will be constructed of 30-foot round cedar poles, 6 inches tip. Insulators will be the Locke porcelain triple petticoat, guaranteed to stand 20,000 volts. The pins will be Locke indestructible steel pins. Cross-arms will be braced with iron braces throughout, and the size of wire will be No. 4 B. & S. gauge, bare copper.

In the sub-station at Riverside the California Electrical Works will place a 10,000 volt switchboard and three step-down transformers to step down from 10,000 to 2,000 volts, having a capacity of 250 kilowatts. The distributing switchboard will also be located in the sub-station, and there will be three 3-wire circuits to operate the incandescent and three 3-wire arc circuits to operate the arc lamps, run from this board.

The board will be constructed of marble and iron, and Whitney instruments will be used throughout. There will be 100 Helios alternating lamps used, ninety for street and ten for interior lighting. The town will be wired for about 1,000 incandescent lights for commercial purposes. The transformers will be of the Wagner type.

ELECTRIC POWER IN A BALTIMORE WOOLEN MILL.

The use of electricity in textile industries is rapidly widening, as its adoption is found to give to textile machinery the perfect regulation so essential to high-grade production. One of the most recent installations has been made in the mills of W. J. Dickey & Son, Baltimore, Md., by the General Electric Company. The electricity is generated by two 90 horse-power moderate speed generators, belted to a horizontal water-wheel. The current is transmitted about 200 feet to the third story of a woolen mill, where it will be used to operate motors and furnish light; in this third story thirty-six 60-inch woolen cards and four mules are to be placed, the cards being arranged in three rows, thirteen to a row, with a line of shafting to operate each row. The motors will be placed either on top of the roof beams or be suspended from the same beams by iron slings and will be connected to the line shaft by a belt. Two of these line shafts will be operated by two 25 horse-power slow-speed motors. For the operation of the mules a 20 horse-power moderate-speed motor will be connected to the shafting.

POWER TRANSMISSION IN VIRGINIA.

The Massie Light and Power Company has been formed in Virginia, with its headquarters at Charlottesville, Va. The capital stock is $50,000. Mr. W. J. Ficklin is president, F. B. Treiber secretary and treasurer. The main object of the company is not to furnish light, but power. The company have a water privilege about four miles from the city, and will transmit their current that distance. A dam is to be thrown across the river. The power building will be of stone and brick. The apparatus for power transmission has not yet been selected.

NIAGARA POWER TRANSMISSION.

THE New York State Superintendent of Public Works, with the consent of the Cataract General Electric Co., which has the exclusive right to occupy canal lands for the transmission of power, has granted a permit to the Niagara Power Company to construct a pole line from Tonawanda to Buffalo and from Tonawanda to Lockport, the poles to be placed upon the tow-path side at least 24 feet from the water line, the poles to extend to such a height above the ground that the sagging wires suspended between them shall at no point be less than 24 feet above the ground. At all points, where such line is carried over the canal the cables must be suspended from steel towers so that the sagging wires across the canal shall be at least 125 feet above the water line.

On April 11 plans and specifications were filed with the Board of Public Works of the city of Buffalo for the trunk line distribution in that city of Niagara power under the franchise accepted by the Niagara Falls Power Company, January 14, 1896. The line from Tonawanda to Buffalo will be over canal lines.

THE LYONS POWER TRANSMISSION SCHEME.

The Société Lyonnaise des Forces Motrices du Rhône, which proposes to utilize part of the water power of the Rhône for the generation of electricity for light and power, has awarded the contracts for part of the plant. The complete plant is expected to produce 20,000 horse-power, and will consist of 16 turbines of 1,250 horse-power each. The available fall varies from 30 feet to 40 feet. The turbines have vertical shafts and are of the reaction type, working with a suction tube, and the generators are connected direct to the vertical turbine shaft. By a special arrangement the large turbines can be made to run at 120 revolutions, while the turbines driving the exciter dynamos run at 250 revolutions. The generators are each to have an output of 1,250 horse-power. To start with, 8 turbines of 1,250 horse-power each, with generators and the necessary exciter dynamos with their turbines, will be erected, the dynamos being made by Brown, Boveri & Co., of Baden, the turbines by the well-known Swiss firm of Escher, Wyss & Co., of Zurich.

ELECTRIC POWER TRANSMISSION AT WALSENBURG, COLO.

For the machinery belonging to Mr. Spencer, a building will be erected on the property just west of the present electric light and power house at Walsenburg. After the building is completed, the machinery will be put in shape and started up. The electricity will be wired over to the Cameron and the Sunshine mines and will furnish them power at much less cost than it can be furnished by steam. The mines will also be lighted by electricity. Mr. Spencer belongs to a company that owns mining property and he says that it is their intention to develop it in the near future. His plant will furnish the power.

CALIFORNIA WATER POWER IN ELECTRICAL HARNESS.[1]

BY H. G. T.

SENATOR S. N. ANDROUS, of Pomona Valley, who has given the subject careful study, said recently that a manufacturing population of over 300,000 might be constantly employed in California if cheap motive power can be had. Costly motive power, derived from coal worth not less than $5 a ton, has been the one great obstacle that has confronted every plan for factories in this State. The only water power to be had is on the turbulent mountain streams, away up in the mountains and rocky, narrow canyons, remote from towns and inaccessible for factory purposes.

The practical demonstration that electricity capable of doing the work of ten, twenty or more thousand horse-power may be transmitted many miles through copper wires, marks the dawn of an industrial era in the State of California, long famous for her gold mines, wines, grains and fruits. A competent authority in the Los Angeles Chamber of Commerce reckons that by electrical power transmission some 280,000 horse-power or more may be developed in the more accessible Sierra Nevada canyons. Experiments have shown that the power may be delivered as cheaply as any in the United States. Senator Androus believes that over 350,000 horse-power may be easily developed in the mountains and transmitted to the adjacent cities and towns, and this, he finds, will be sufficient to propel every street car, elevator and printing press in California, to heat and illuminate the whole Commonwealth and to run all kinds of factories needed in California for another decade.

The electrical-power plants that have already been set up at Pomona, Redlands and Folsom, in California, have shown what electricians and manufacturers may expect. All have exceeded the expectations of their projectors in the cheapness and convenience of electrical transmission. Some $1,400,000 has been invested in such electric plants in this State, but projects are being pushed with all speed for three similar plants—to cost over $4,000,000—that will develop about 18,000 horse-power. The Californians have a reputation of doing nothing by halves, and it seems a mild statement that a dozen millions of dollars will be invested in electrical plants along the canyon streams and in copper wire and machinery in the Golden State in the next five or six years.

A company of capitalists in Pomona saw the possibilities in San Antonio Canyon, sixteen miles north of the town, and with a capital of $250,000 they formed a company, the San Antonio Electric Power Company, for prosecuting the work. The water right was easily and cheaply bought, because the irrigation companies owning the stream and canyon would not lose a drop of water by the operation of the electrical company. The water is merely run through a mammoth iron pipe, dropped upon a water wheel, and then returned clear and undefiled to its original bed to go flowing down into the valley below for the orange and lemon groves and the alfalfa fields. It took a year to complete the work for the electrical company. An artificial waterfall of 387 feet was created, immense water-wheels were set up in a power-house in the canyon, and electrical dynamos with a complement of transformers having the pressure of 10,000 volts were established there. Next a No. 7 copper wire was strung on poles from the power-house to San Bernardino, twenty-eight miles away to the east, and Pomona, sixteen miles down in the valley south of the canyon. At San Bernardino and Pomona sub-stations were erected for the switchboards and the banks of lowering transformers, and then the company was ready to deliver electric power and illumination to patrons in San Bernardino, Ontario and Pomona.

For two years the San Antonio Electric Company has been dealing out in Pomona, Ontario and San Bernardino from 180 to 240 horse-power without an hour of delay or any accident or mishap. The company employs but four men in the electrical service, and it can sell power as cheap as any company in the Union. One man attends to affairs in the power-house in the canyon, but so mechanically and smoothly do things run there month after month that his duties are like those of a lighthouse-keeper. On several occasions the San Antonio Company has joined the circuit so as to make a continuous circuit of eighty-five miles, when it has sent 186 horse-power over the whole circuit. The power has been used to illuminate the towns of Pomona and San Bernardino, and to operate street cars and stationary engines.

In the last few weeks the most important system for long-distance electrical transmission in this country, outside of that of Niagara Falls, has been finished at Folsom, near Sacramento. A grand celebration extending over three days, and participated in by thousands of people from every part of California, marked the completion of the work and the practical demonstration of the possibility of transmitting three separate currents 10,000 volts over the wire lines to Sacramento. The American River furnishes the power at Folsom. A dam was built across the river and a stream of 85,000 cubic feet a minute is run through a tunnel and over turbine wheels, where power is created for the mammoth electric dynamos in the power-house near at hand. The water is used further down the valley for irrigating, and it is enough to cover well 300,000 acres of land.

In the dynamo room are four three-phase alternating-current generators, each capable of developing 1,000 horse-power, the shafts of which are coupled direct to the shafts of the four water-wheels. These dynamos are the largest in the world, with the exception of those at Niagara Falls, and weigh about forty tons each. The electric current developed by these enormous machines is passed through raising transformers, which increase the voltage to 10,000 volts, at which pressure it passes through the wires of the transmission lines. There is a double-pole line over the twenty-four miles from Folsom to Sacramento, thereby guarding against any delay for repairs or renewals, one line always being in reserve. It is estimated that four-fifths, or 80 per cent., of the electric power developed is transmitted to Sacramento along the bare copper wires strung on poles. The 20 per cent. of loss could be much reduced, if necessary, by using heavier wires, but with the enormous water-power at Folsom it is not desirable to increase the copper wire beyond a certain point. The electrical energy from Folsom is used to propel street cars in Sacramento, to illuminate and heat the city, to run the machinery and presses in the State printing office and to operate stationary engines throughout the city. Two factories for the manufacturing of boots and shoes are soon to be established in Sacramento. A company of Boston and New York capitalists has been at work in Los Angeles and Kern Counties for six months in devising plans for developing electric power in the Kern River, among the chain of mountains west of Bakersfield in the San Joaquin Valley. The company has spent over $15,000 in getting water rights, and it proposes to develop some 12,000 horse-power in the Kern River, after the engineering methods employed in the San Antonio Canyon, and to transmit the same through copper wires, a distance of 110 miles from Los Angeles City. It will require four or five years and several millions of dollars to finish the undertaking. The company has engineers now at work in the mountains making surveys for a series of dams to be built across the river. It is reckoned that the motive power the company thinks it can bring to Los Angeles will heat and light the whole city, and will furnish sufficient power for half a dozen large factories, besides propelling every street car and engine in Los Angeles and its suburbs.

Down at San Diego, where one of the most famous of the big irrigation dams of the world, that at Sweetwater, has stood for seven years, it is proposed to get some 3,000 horse-power at the dam and transmit it to San Diego and National City, twenty miles distant. U. S. Grant, Jr., and Jesse Grant, sons of Gen. U. S. Grant, are at the head of a company which has the plan in view. Electrical engineers have reported that nowhere can horse-power be developed and transmitted cheaper than there in San Diego county. There are other great water powers in the San Diego mountains and canyons, and it is believed the Atchison, Topeka and Santa Fé Railroad Company is interested in having its civil engineers search there for a new motive power for its locomotives on the Southern California division. At this writing a committee of three Californians is in London seeking to interest capital in the field of electrical power development in Southern California for railroad locomotive and cotton and woolen factory uses.

In that branch of the Sierra Nevada back of Fresno and Stockton, in the upper part of the great San Joaquin Valley, a company of Chicago and San Francisco capitalists has had electrical and hydraulic engineers at work ascertaining the amount of power that may be created there, and the best means of conveying it from the mountain streams and waterfalls to use in Stockton, Fresno, and, possibly San Francisco. Enough work has been done to show that some $3,500,000 will be necessary for the work, and that at least 40,000 horse-power may be sent in an electric current from the transformers over several copper wires through the San Joaquin Valley. The distance this power will be carried is about 150 miles in all, something that would not have been seriously considered among electricians several years ago.

[1] Abstract from correspondence in the N. Y. "Evening Post."

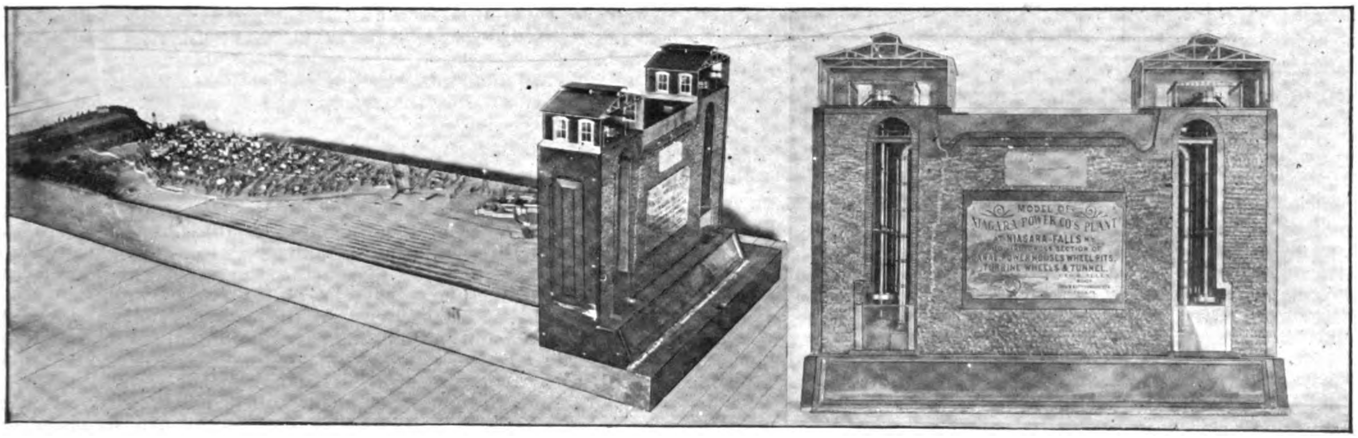
POWER FROM NIAGARA TO NEW YORK.

BY ORRIN E. DUNLAP.

IN connection with the ingenious and feasible plan of operating, at the National Electrical Exposition in New York City by Niagara energy, the interesting little model of the Niagara Power Company's plant, whose great original will itself furnish the current, I believe that a few details as to the model now being set up in New York will be of interest.

Fig. 2 gives a front view of the model, showing the great electric power-generating plant of the Niagara Falls Power Company in miniature. In Fig. 1 is seen a bird's-eye view of the upper Niagara River from the big power house to the gorge, the city of Niagara Falls, the Niagara gorge and a bit of Canada on the distant side. So well planned is this model that it shows the city of Niagara Falls and surrounding locality from a point just beyond the line of the power tunnel on the north to the center of Goat Island on the south, and from a point beyond the Clifton House, Canada side, on the west to a point beyond the big tunnel canal on the east. The model is 12 feet long by 3 feet 6 inches wide. The height of the model when on exhibition is about six feet, but one-half of this is in a fine glass-case, which protects it from meddlesome hands and dust.

In placing the model on exhibition those in charge will take great care to see that the points of the compass are faithfully maintained, and thus those who study its detail and plan will have a correct understanding of the location of the river, the power plant and the city of Niagara Falls.



FIGS. 1 AND 2.—WORKING MODEL OF THE PLANT OF THE NIAGARA POWER CO., AT THE NATIONAL ELECTRICAL EXPOSITION.

By glancing at Fig. 1 the reader will see that at the east end of the model a little wooden case rises above the main surface of the model, and, standing in front of it, one learns by a statement on a metal plate that they are looking at a model of the Niagara Power Company's plant at Niagara Falls, N. Y., and such it is. The power houses, wheel pits, cross-section of the canal, turbine wheels and the tunnel are all before you. In this is found the actuating thought that led to the construction of this truly wonderful piece of work. Day after day many visitors at the Falls make eager inquiries as to the workings of the tunnel and its object. Some find this a difficult matter to explain, but here it is all plain. In this model is shown what can be seen in no other way, for it would be utterly impossible to take all the visitors down into the deep wheel pit to show them the workings of the turbines. When power is applied water will flow down the penstocks upon the turbines, which will set in motion the turbine shaft, to the dynamos that will generate the power in the original installation. There is a sectional view of all this, showing the turbines, the penstocks and shafts. On the cut is shown the dynamos with a small flight of stairs leading to the top of them. As the water passes from the turbines it enters a drift or small tunnel leading to the main tunnel and is carried through it to the gorge below. Standing on the north side of the model a sectional view of the entire length of the tunnel and the water passing through it is obtained. Air bubbles are pumped into the water so as to make it more perceptible to the sight.

To one standing one the west, or Canadian, side of the model the portal of the tunnel, the Niagara gorge, the American fall and a portion of the lower river are visible. True to nature, the little steamer, "Maid of the Mist," is seen near the dock on the American side. The arrangement of the American fall and the center fall, the little fall between Luna Island and Goat Island, is most perfect. The effect is created by a porcelain plate tinted and burned in.

Six electric lights located in various parts of the city and three lights in the Cataract House shine forth and add to the scene. While the model was at the Falls they were operated by a storage battery concealed beneath, but in New York Niagara power, live and stored, it is expected will be called into service.

One thing that all will be impressed with is the beauty of the river as it is represented. The upper river is shown from the Falls to a point above where the tunnel canal taps the river. All the islands and bridges are shown. The river-bed, on the part above the rapids, is of glass. Midway down the south side of the model the glass ends. To this point the water flows underneath the glass when it runs out and flows over a bed made of lead, representing rock. Where the rapids of the upper river are the lead is wavy, and the rapids are shown distinctly. As the water passes over the precipice it drops behind rocks at the bottom and passes underneath the glass river-bed of the gorge.

In this connection it is interesting to note that while the model was made by George R. Allen, of Philadelphia, that part of it which has to do with the power development was made under the supervision of Coleman Sellers, Chairman of the Board of Engineers of the Cataract Construction Company, thus assuring perfect accuracy in the portrayal of this truly wonderful plant.

Quite naturally, in such a work, the buildings of the city hold the eye, and among those that attract most attention are the Cataract House, the center power station of the Niagara Falls Power Company, the many buildings that compose the plant of the Niagara Falls Paper Company, and the various churches in that portion of the city shown. All these buildings are made of wood, excepting the famous old Cataract House, which is of cardboard. As a whole, the model is destined to do much to give visitors a clear idea of what has been done to develop Niagara power.

In the construction of the model the scale used was one of about 100 feet to an inch and a half. Thus a comparison of this fact with the dimensions above given will give one a very fair idea of the model. All the streets and buildings shown are perfect in form and direction. To one acquainted with the city of Niagara Falls, it affords pleasure to pick out well-known places. The total number of buildings shown is 197, while the number of trees which grace the streets of the city in the model is 1,150. Every one of these trees Mr. Allen, the model-maker, tried to locate with precision.

"BUSTED" BOILERS IN AN ARGENTINE PLANT.

A telegram from Santa Fé states that two large boilers in the electric light factory exploded on Sunday night. The roof was blown off and the boilers were carried to a distance of two squares, destroying trees and injuring houses on their way. Three persons were injured and one of them died. The factory cost $120,000 gold.—Buenos Ayres "Herald," Jan. 21.

THACKARA & CO. have had their big gas and electric fixture establishment burned out.

Electric Lighting.

THE NEW THREE-PHASE ELECTRIC LIGHTING SYSTEM AT SALT LAKE CITY.

In August, 1895, it became necessary to make immediate provision to increase the dynamo capacity in Salt Lake City, in order to meet the demand for lighting. A contract had been made with the Big Cottonwood Power Company for the supply of power, but there was no prospect of getting this power until the spring of 1896. By this contract the Big Cottonwood Power Company have undertaken to develop a water power in the Cottonwood Canyon and transmit electricity over a distance of 14 miles into Salt Lake City, and there to sell the power to the Salt Lake & Ogden Gas & Electric Light Co. This undertaking was fully described in "The Electrical Engineer" of Sept. 12, 1895. The Big Cottonwood Power Company will install a three-phase alternating system with a 10,000-volt transmission, stepping down at the distributing station in Salt Lake City to 2,000 volts. With these plans in view it was deemed advisable to put in three-phase dynamos at the Salt Lake electric light plant of sufficient capacity to supply the commercial center with incandescent lights, and machinery for this purpose was purchased from the General Electric Company and erected last November.

Generators.—The generating machinery consists of two 150

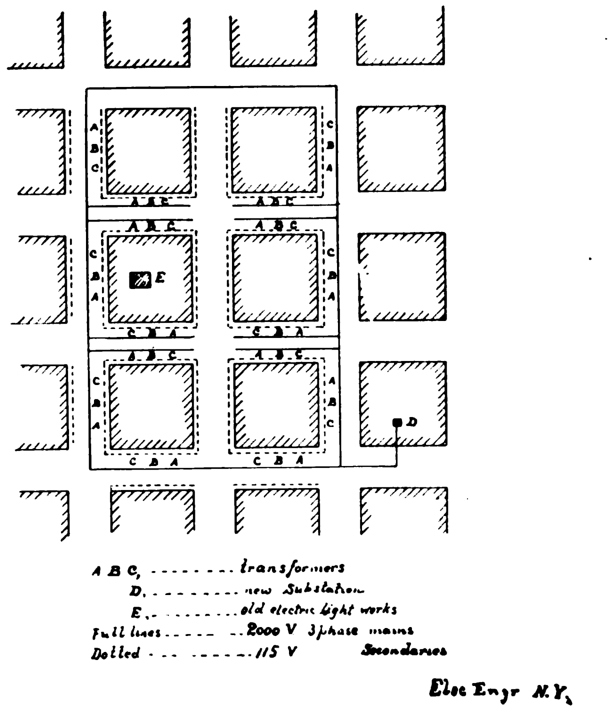


Fig. 1.—Plan of Primary and Secondary Mains in Commercial District.

kilowatt and one 50 kilowatt three-phase alternators. One of the large dynamos is belted to a countershaft with other dynamos and driven by a 600-horse-power Corliss engine, which runs at 100 revolutions per minute. The second is driven off the flywheel of a 250-horse-power cross-compound Armington & Sims engine, running at 230 revolutions. The third dynamo is used for the day load, and is driven off a 150-horse-power cross-compound Armington & Sims engine, together with two Edison dynamos used to supply power.

All the dynamos are designed for 60 cycles. They are compound wound and have iron-clad armatures of the latest type. The 150-kilowatt dynamos are wound for an output of 2,300 volts and 37 amperes at a speed of 600 revolutions; the 50-kilowatt dynamo is wound for an output of 2,300 volts and 13 amperes, at a speed of 900 revolutions. The manufacturers guarantee a commercial efficiency of 94 per cent. at full load on the large dynamos and a temperature not to exceed 70 degrees Fahrenheit above the temperature of the surrounding atmosphere, after a continuous run at full load for 10 hours. There has been no opportunity of testing the dynamos for efficiency at present, but they come well within the temperature guaranteed.

Switchboard.—The switchboard consists of five slabs of pink Tennessee marble, 90 inches high by 30 inches wide. Three of the panels contain switches for each of the three dynamos. One panel is for the measuring instruments, and the fifth panel is for the circuit switches and voltmeter. The dynamo

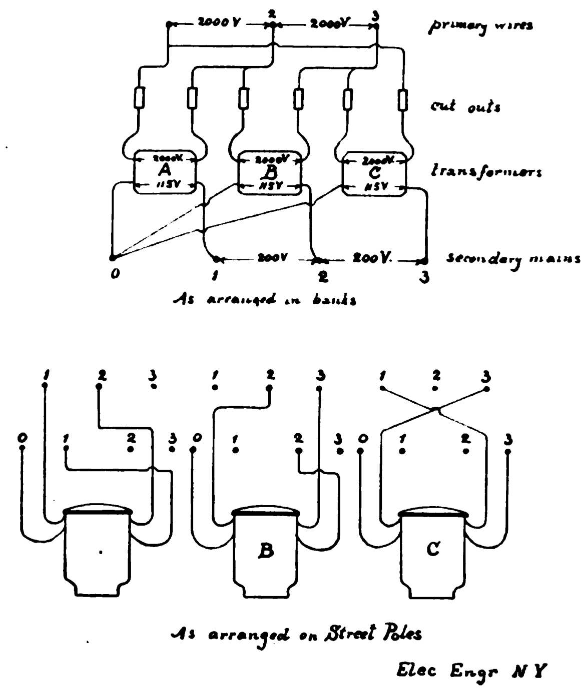


Fig. 1.—Transformer Connections, 3-Phase System.

panel is fitted with a Carpenter enamel rheostat for regulating the exciting current; one exciter double-pole switch; one three-pole main switch; one equalizer switch, for parallel running; one ammeter for measuring the main current on one leg of the three-phase system, and three high-tension fuses and a synchronizing switch. At the back of the board are the three high-tension mains' bus-bars, the equalizer bus-bars for connecting all the compound windings together, and three lightning arresters of the T.-H. magnetic blow-out type, with an additional protection of a flat coil of a few turns of large wire between the arrester and dynamo. Each dynamo has one transformer, which is so connected to a bus-bar that, by throwing a small switch, it can be used for lighting a pilot lamp or be put in series with the other transformers for synchronizing.

The effective current, as measured at full load on one wire of the dynamo, is 37 amperes upon the larger and 13 amperes upon the small dynamo. The total effective current on the three wires is about 1.73 times that on one wire. This being the ratio between the ordinates of one sine curve and the added ordinates of three sine curves at phase angles of 120 degrees. On the instrument panel are three main amperemeters for registering the whole current sent out

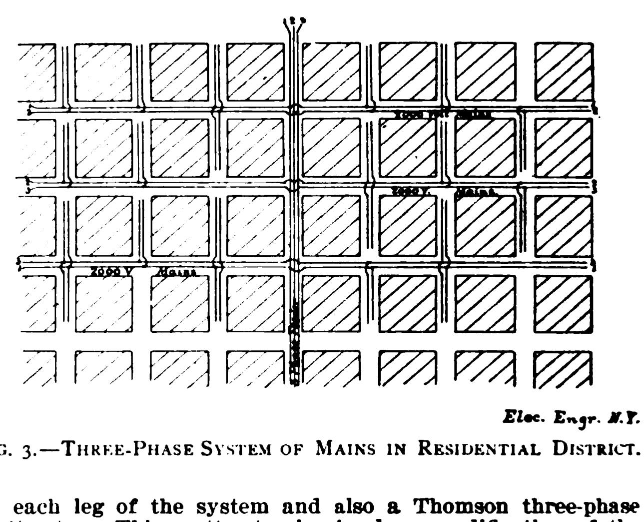


Fig. 3.—Three-Phase System of Mains in Residential District.

on each leg of the system and also a Thomson three-phase wattmeter. This wattmeter is simply a modification of the ordinary Thomson meter, and consists of three separate

meters, the armatures of which are all on the same spindle. On the fifth panel are arranged four three-pole circuit switches, four sets of circuit fuses and a Thomson-Houston voltmeter, arranged with a switch for connecting to any dynamo or any circuit. In addition to these instruments a Bristol recording voltmeter is fixed in the station. The whole board is protected by a wooden canopy, presents a very handsome appearance and is extremely simple to manipulate.

The compound commutators of the dynamos run absolutely sparkless, and there is no trouble at all in synchronizing. It may here be mentioned that the self-induction in the armatures of these dynamos is such that it is impossible to do any damage by a short circuit. Shortly after starting, a short circuit occurred on the main lines, while the small dynamo was running; the result was that the potential at the dynamo dropped off just as if the exciter switch had been suddenly opened, and, furthermore, the dynamo would not give any potential at all when running upon the short circuit. These dynamos, however, will carry 25 per cent. above their rated capacity without any loss of pressure.

The Distributing System.—The distributing system consists of a three-wire high-tension network and a four-wire network of secondary mains. The accompanying plan (Fig. 1) shows how these mains are distributed over the business district. The transformers are placed upon the poles which carry the wires, and the connections are made as shown in the diagram, Fig. 2.

In carrying out a system like this it is, of course, important that the transformers should be fixed quickly without any fear of getting the connections wrong. In order that the linemen may not be able to make any mistake in this, the wires on the poles are numbered, as shown, and the transformers are also lettered. The diagram also shows the position in which the transformers are placed in the streets, and the arrangement is such that in case of fire it would be very easy to cut off one portion of the district without interfering with the rest of the lighting.

In order to save the loss in transformers during the hours of light load, arrangements are being made for cutting out a certain number of the transformers during the daytime, leaving the rest to supply the secondary mains. The transformers are wound for a ratio of 18 to 1, and it will be noticed that the secondary mains consist of a neutral wire and three others. By this means it is possible to get 115 volts between the neutral and any of the three other wires for incandescent lighting, and 200 between any two of the other wires for motor service.

With the exception of one or two little difficulties inseparably connected with installing such a system as this during the heaviest lighting season in the year, there has been no difficulty whatever, and the dynamos and all other apparatus work perfectly. There is no difficulty in balancing up the three legs of the system, and, in fact, once the transformers and the secondary mains are fixed, it is said to be easier to manipulate than an Edison three-wire system.

As soon as the Cottonwood power station is ready for work the preparation will be commenced for connecting the residence district on the three-phase system. At present these districts are supplied on the ordinary 1,000 volt single-phase system. The diagram, Fig. 3, shows how the connections will be made for the three-phase.

The arrangement of the streets in Salt Lake City are convenient for carrying out the necessary changes. The streets run north and south and east and west. The existing 1,000 volt mains run east and west. The three-phase feeder, as shown, will be brought up one of the streets running north and south through the center of the residence district, and each of the streets will be attached to this feeder, as shown in the diagram; thus, where there are three streets, each one of the streets will form one leg of the three-phase system, and the three legs will be balanced by throwing the side streets on to whichever leg requires strengthening or weakening, as the case may be. All the transformers at present installed in stores are wound for 1,000 volt primaries and 52 volt secondaries. Some of the stepdown transformers, supplied by the Big Cottonwood Power Company can be connected for 1,000 volts, and it is proposed to connect up the three-phase feeder to the distributing station, as shown in the diagram, at a pressure of 1,000 volts. The existing transformers would not be very efficient at 60 cycles per second, but as quickly as possible the old type transformers will be transferred to Ogden, while new type transformers will be fixed in the residence circuits, and then as soon as sufficient new type transformers are fixed the voltage will be raised to 2,000 and the house lamps changed from 52 to 104.

This is an outline of the system proposed to be pursued in changing over the residence district from the existing system to the new three-phase system. It will necessarily take some time to carry out this work, but there are portions which can very easily be connected up, while it will take several months to prepare other portions of the town.

In a great many parts of the residence district the houses are so close together that it is very easy to fix one or two transformers to supply ten houses. These transformers will be fixed on the street poles and a short length of secondary mains will be run, from which the houses will be supplied. At these places it is proposed to place two transformers, one, say, for 100 lights and another for about 20, with an automatic switch to cut out the larger transformer, when the number of lights does not exceed the load of the smaller, and so save the loss of power at light load.

From the fact that the installation presents so many points of new and improved central station practice, its operation will be watched by electric light and power men throughout the country with keen interest. The active conduct of this important undertaking has devolved on Mr. R. F. Hayward, the well-known general manager of the company, who has carried it to its present successful stage with characteristic energy and ability.

DIFFUSION AND OPALESCENCE WITH ROENTGEN RAYS.

Elihu Thomson

So far as the writer is aware the phenomena presently to be described have not hitherto been alluded to by writers or experimenters on Röntgen rays. They are the phenomena of diffusion of such rays by certain classes of substances in such a way that such substances must come to be regarded as opalescent, or to act like opal glass in ordinary light, or like milky liquids, a diffusion of incident rays taking place from the interior and exterior of the mass.

Some substances are found to behave with Röntgen rays in the way that compacted snow or translucent ice acts in diffusing light. Let a fairly large metal screen, such as a brass or iron plate of 1-16 to ⅛ inch in thickness, be suspended in a vertical plane about a foot or more from a Crookes tube kept in action and emitting rays toward the plate. On the side of the plate opposite to that nearest the Crookes tube there will, of course, be a space in shadow free from Röntgen rays. This statement, though true in the abstract, may not express the whole truth. It may easily happen that an exploration with a fluorescent screen tube or fluoroscope back of the metal plate will show that the rays are not absent there, but appear to come around the edge of the plate. This phenomenon has been alluded to by Mr. Edison recently and used in support of his suggestion that Röntgen rays are simply high pitch sound waves.

But upon close examination it will be found that the rays back of the metal shield are, at least mostly, due to diffusion from surrounding objects; the walls of the room or the floor, or objects in the room receiving the rays and scattering them. Further examination will also disclose the fact that bodies differ greatly in their diffusive power, and that substances such as paraffine, wood, paper, pure rubber, cloth of cotton or wool, the hand of a person, etc., which are comparatively transparent to the rays are also fairly vigorous in diffusing them.

The diffusion is not merely from the surface or irregular reflection. This is shown by the fact that the surface may be smooth or rough and that the rays come even from the back of the object and from portions not exposed directly to the original rays. This indicates a true opalescence like that possessed by opal glass with ordinary light. It will be seen from this that the shadows of opaque objects imbedded in tissue at considerable depths can never be so black or dense as when the objects are merely surrounded by air. Liquids appear to possess the property as well as solids. The diffusion appears to take place in all directions within and outside of the mass of the substance.

If the fluorescent screen tube used have metal sides of some thickness the large metal plate screen mentioned above can be dispensed with. In this case it suffices that the screen tube be turned so as to be directed at right angles to the direction of the rays or be turned away from the Crookes tube so as not to fluoresce. Pieces of various substances may now be placed opposite the end of the screen tube, but in a position to be partially or wholly exposed to the rays. The pieces will become virtually sources of the rays and the rays diffused by them reaching the fluorescent screen will cause it to emit light.

By placing two exactly similar fluorescent screens at opposite

ends of a dark tube and employing a Bunsen photometer screen movable, as usual, between the screens, a comparison of diffusing power of different materials might be made by subjecting the pieces placed near the ends of the photometer tube outside, to equal radiation from the Crookes tube. The same instrument might be employed to measure the relative merits of Crookes tubes as producers of the rays. The same electrical discharges would be passed through both tubes while opposite each end of the "fluorometer." So also the comparative values of different fluorescent screen material could be tested by slight modifications in the use of the instrument.

By comparing the density of the shadow of a piece of sheet lead when back of a block of wood or paraffine and close to the fluorescent screen, with that of the same piece when the wood or paraffine is between the screen and the lead the effects of diffusion in the latter case in lighting up the shadow are clearly seen on a fluorescent screen.

Though the experiment has not been tried as yet, the writer thinks that a cloud or mass of fine particles of water from a steam jet would diffuse the Röntgen rays. It is well known that the higher pitch light waves are most readily diffused and absorbed by fog, and if Röntgen waves be very high pitch waves similar to light waves this diffusibility need not surprise us, the new rays to be in a sense detectors of molecular turbidity. Whether true gases have the power of diffusing the rays is not known, but the diffusive power, if it exists at all, will be small and difficult to detect.

Metal plates gave apparently little diffusive effect, appearing to reflect feebly at angles equal to the incidence angles. The phenomena of reflection from surfaces have been investigated very recently by Mr. Tesla, and a number of values obtained for the relative reflecting powers of metals, etc. The diffusive action herein noted is different altogether from reflection, and is obtained at all angles from the surfaces and from the interior of the materials upon which the original rays fall.

Note.—The term opalescence is here used to mean milkiness, and not a play of colors, which the term is often used to signify.

KINEMATICS OF THE ROENTGEN RAY.

H. M. Stine

THROUGHOUT the writer's experiments with the Röntgen rays the shadows observed on a sciagraphic negative have been most carefully studied. From the first the penumbral shadows seemed to indicate, when the experiments were carefully plotted, that a limited circular area of the bulb, opposite the cathode, was the prime source of the ray, a fact which

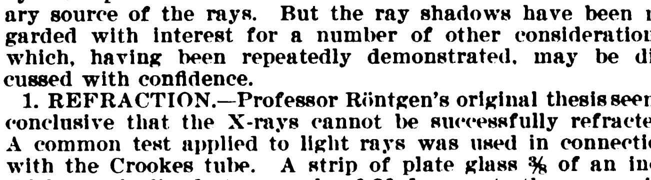


Fig. 1.

I have since fully confirmed. In this article it has been clearly proven that the entire inner surface of the tube bombarded by the repelled molecules is also a more or less weak secondary source of the rays. But the ray shadows have been regarded with interest for a number of other considerations, which, having been repeatedly demonstrated, may be discussed with confidence.

1. REFRACTION.—Professor Röntgen's original thesis seems conclusive that the X-rays cannot be successfully refracted. A common test applied to light rays was used in connection with the Crookes tube. A strip of plate glass ⅜ of an inch thick was inclined at an angle of 30 degrees to the rays, with a metallic rod so placed as to show a broken shadow in case of refraction. It is almost neeedless to state that the shadow was unbroken. Some experimenters have erroneously interpreted penumbral shadows of round rods as indicative of refraction. This error is readily resolved by the method indicated below.

2. REFLECTION.—The attempt was made in a great number of ways to produce reflection from glass and metallic surfaces, singular how the erroneous belief in the reflection of the Rönt- but in all cases the answer was clearly negative. It seems gen ray has taken hold. Experimenters who have announced reflection have seemed to ignore some of the most elementary principles of physics. The maximum reflection stated has been 2.5 per cent. and one places it at 0.4 per cent. The reflection of a wave is molar, and for an angle of 45 degrees should, from the surfaces employed, have been in excess of

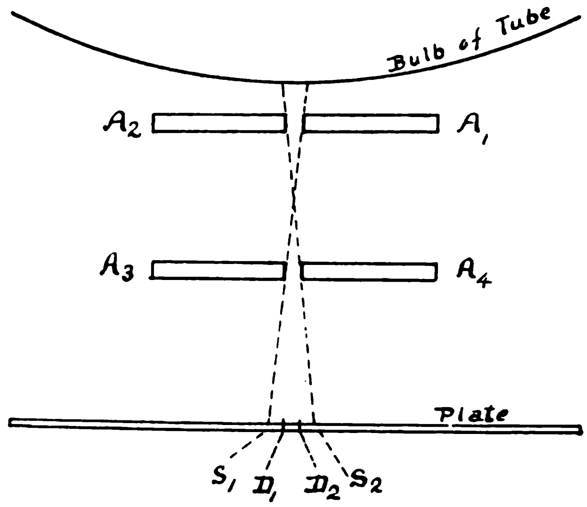


Fig. 2.

50 per cent. The slight reflection would indicate molecular and not molar origin. The nearness of the reflecting plate to the bulbs, taken with the high potential employed, shows that the slight reflection noted was due to the reflecting surface acting as a secondary source of the Röntgen ray. A careful study of Lenard's experiments leaves this in no doubt.

3. DIFFRACTION.—This is naturally one of the first kinematical points to be investigated in the Röntgen experiments. It was noticed that when the opaque object was some distance from the plate, pronounced penumbral shadows resulted. These were of such width as to indicate diffraction. However, when such shadows are plotted back to the tube they are found to be purely penumbral, and not caused by diffraction.

To completely demonstrate this point the experiment illustrated in Fig. 1 was undertaken. Here A_1 to A_4 are brass plates one inch wide and ⅛ inch thick, and of the length of the dry plate employed. They were first fastened together, so as to leave two parallel slots ⅛ of an inch wide. These plates are placed within ⅜ of an inch of the bulb, were one inch apart, and rested 1⅛ inches above the dry plate. The resulting sciagraph is shown in Fig. 2. In the diagram S_1 S_2, the edges of the penumbral shadow are very sharp and distinct. The direction of the rays is indicated, showing that there was absolutely no diffraction. This experiment has been modified in a variety of tests, with always the same result.

All the more interest attaches to this experiment in view of a recent article on "Röntgen Phenomena Due to Sound Waves."[2] In this article the author states that the rays reenter the geometrical shadow of a steel plate. All students of kinematics know that from the relative sizes of the raysource and opaque plate such marked diffraction as is here indicated could not take place.[3] This statement is made not on academic grounds alone, but after carefully going over the experiment as outlined. A steel plate ⅛ of an inch thick was employed, and the calcium tungstate fluoroscope used as a detector. No diffraction could be detected. The shadow was sharp or more less penumbral, according to the relative position of the plate and bulb.

Another curious result has erroneously been interpreted as due to diffraction on refraction, a phenomenon which may be called "undercutting of the shadow." If the opaque objects are a little separated from the dry plate and placed so as to be at an angle and nearly in contact the line of shadow will be broken and creep out toward the abutting object. The explanation of this is simple, if the source-area of the ray is borne in mind. It is due to a shielding from the rays on the part of the abutting object.

4. INTERFERENCE.—Evidences of apparent interference are as common as those of diffraction. Certain dark lines have been in frequent evidence, and for a time were perplexing. These are shown dimly in Fig. 1, though they are very distinct in the negative; they are also designated by D_1 and D_2, Fig. 2.

[1] Electrical Engineer, April 8, p. 357.
[2] Electrical Engineer, April 8, p. 353.
[3] Daniell's "Physics," pp. 114, 115 and 136. [4] Idem, pp. 136, 137.

They may be explained by reference to the ray-source. They are due to the rays in the perpendicular planes in the edges of strips A_1 to A_4.

As would be expected, the lines are darker immediately under the bulbs. By plotting out the entire ray distribution it will be seen that such lines mark out areas where the rays are thickest. These lines are always to be seen defining the boundaries of plates of metal or glass placed directly under the ray-source. The edges of the brass strips being rough were not suitable for reflection, nor could such lines be due to reflection, since they do not lie in any reflected plane. The experiment in Fig. 2 was repeated with ordinary light. Here the flat side of a gas flame replaced the bulb of the Crookes tube and a piece of white paper the dry plate. The dark lines were now lines of brightest illumination. Now was this due to reflection, for reasons just stated? Neither can such lines be explained by interference, for it is to be noted that they are parallel throughout the entire length. Were they due to interference they would be hyperbolic lines diverging from their center.

Some observations on the theory of the X-rays may be permissible. In the article before alluded to the apparent diffraction was taken to indicate that these waves may resemble sound waves. This theory is by no means here presented for the first time. It is suggested by two additional facts. Since we know the source of the ray to be the bombarded walls of the bulb this might be regarded in the light of a vibrating disc. In such cases the vibration must be longitudinal rather than transverse.

The errors in the original deduction are obvious. Sound waves are always molar in origin; ether waves, molecular or atomic. None but molar waves in a medium like the air could so flow around an opaque plate. Sound waves would do this, but can sound waves produce chemical or fluorescent effects?

Further, we now know that the Röntgen rays pass more readily through a vacuum than the air in which they seem to be absorbed, probably by charging the air molecules. Neither of such properties belongs to sound waves.

Much as the older and academic school of physics dislikes to acknowledge it, the evidence in favor of the longitudinal nature of the Röntgen rays is so increasingly strong that it seems wellnigh impossible to explain it away. One of the last resorts of the transverse theory is to attribute the production of the ray to fluorescence. This in reality is an accidental rather than a necessary accompaniment. How else may the action of aluminum-walled tubes or of the so-called "focusing" tubes be explained?

If the ray be acknowledged as a longitudinal vibration it does not follow, as some assert, that it possesses a close resemblance to gravitation. One observation alone shows this error: A metal plate may shield an object placed behind it from the X-ray, but there is no known method for screening an object against gravity, for this would be in violation of the conservation of energy.

ROENTGEN RAY AIR-WAVE THEORY.

BY EDWARD P. THOMPSON, M. E.

I TRIED an experiment which others may also have performed, as far as I know, and which acts as the basis of an argument against the theory of propagation of X-rays by waves of material particles. In the experiment referred to, a shadow of an uncharged Crookes tube was outlined upon a fluorescent screen by the X-rays from a charged Crookes tube. From the fact that the shadows of the electrodes of the uncharged tube occurred, we have evidence that the X-rays passed through the evacuated space. If only the shadow of the vacuum tube itself had been cast, and not those of the electrodes, then it would be fair to conclude that the vacuum would not transmit the X-rays, while the glass of the vacuum tube did the same, as sound would be communicated from one side of the vacuum tube to the other by the vibrations of the glass in unison with the undulations of the air.

Numerous experiments of a similar nature suggest themselves, and from their very simplicity ought to be conclusive. Permit me to propose the following: Support a small fluorescent screen in the center of a large and highly exhausted bulb, so that it does not touch the glass, and let such a support consist, in part, of a fine thread or a coiled fine wire—to prevent communication of vibrations of the glass walls of the bulb to the screen, if such vibrations exist. In case the screen becomes luminous, it would prove that the X-rays were transmitted through a vacuum—overthrowing the air-wave theory in the first experiment. The residual atmosphere, some will say, acts as the medium for the formation of waves, but there should be a proportional reduction of luminosity when compared with that of a piece of the same screen outside of the vacuum bulb in addition to the very slight reduction due to the glass itself.

INFLUENCE OF TEMPERATURE ON X-RAY EFFECTS.

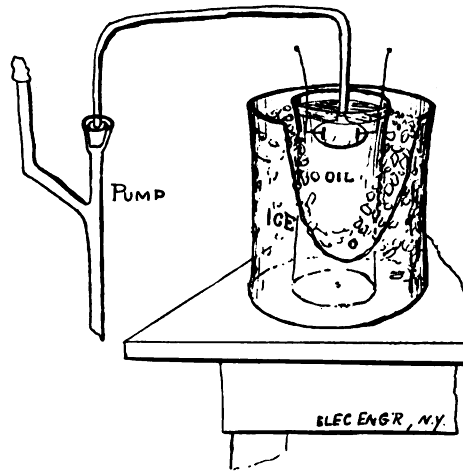
BY

Thomas A. Edison.

FURTHER experiments with the X-ray of Röntgen and Lenard have brought out some important facts which I think will open a wide field for further experiment. It has been noticed by myself, and perhaps many other experimenters, that the relative permeability of different material for the ray was not constant. Different tubes and conditions produced a change in the relative permeability.

It occurred to me that a great change might take place if the bulb was kept at a low temperature. I accordingly placed a tube on the vacuum pump, immersing the tube in a stout battery jar 14 inches high and 8 inches in diameter, the glass being 5-16 inch thick. The jar was filled with heavy paraffin oil. This jar was placed in a large glass jar, 12 x 12, thickness of glass ⅝ inch. This outer jar was filled with water and kept supplied with ice, as shown in the diagram. When the tube was excited the ray which came through the oil to the fluoroscope was of a different character to the ray which comes from the same tube in air. The field of the fluoroscope was bright, but the hand held in front of it gave scarcely any differentiation between the flesh and the bone; one was nearly as transparent to the ray as the other. The hand scarcely altered the brightness of the illumination, and this was true whether the tube was made weak or strong.

A sheet of crucible steel 1-16 of an inch thick, usually cuts off all the ray with tube in air. When held between the bulb



X-RAY TUBE IMMERSED IN AN OIL-ICE BATH.

and fluoroscope, under the new conditions, the steel was quite permeable, giving a fairly strong illumination of the field. A shadow was cast by a piece of steel 2 inches wide by ½ an inch thick. This shadow could be seen through ⅛ of an inch of steel, not only through the oil, but through the oil, water and ⅝ of an inch of glass!

In explanation of these phenomena, we may hazard the view that either the low temperature of the residual glass and gas bulb has increased the length of the waves, or the oil, etc., has absorbed the short waves and permitted the long ones to pass. If the first explanation is correct, a reversal of the condition of the experiment, that is, high temperature conditions, should give shorter waves and sharper shadows; if the second explanation is correct, then all we have to do is to find some liquid or material that well absorbs the long waves and permits the short ones to pass, thus giving sharp shadows.

These experiments show that further investigation should be made in prismatic analysis with liquids, etc.

From continued work in this field I find that bulbs which are spherical at the point where the maximum fluorescence appears are very liable to be pierced, not by the spark, but by a focus of bombardment, resulting in the heating to the melting point of an extremely small part of the glass.

In most cases, if the center of fluorescence is watched, a

non-fluorescent portion will appear; if now the power of the coil is increased there will appear in this non-fluorescent area an extremely fine point which will grow red hot and be forced inward by the atmospheric pressure. I have seen these spots come and perforate the bulb within two seconds. I find that it occurs when the electrodes are perfectly flat, and that it proceeds as a thin concentrated pencil from the exact center coil is increased there will appear in this non-fluorescent area of this concentrated bombardment is increased and the tube can be worked at a higher power before heating. The best remedy is to permit the central ray to strike the glass at a low angle; this greatly increases the area, and prevents the trouble.

X-RAY PHOTOGRAPHS FROM THE WIMSHURST MACHINE.

BY E. W. RICE, JR.

THE literature of Röntgen rays has become so voluminous that it is with great reluctance that I venture to add anything to it. However, in the course of some experiments which I have been conducting during the past few weeks for my own diversion, I have succeeded in making several satisfactory pictures under conditions, which, as far as I know, are quite novel, and which may be interesting to other experimenters.

The source of electricity for these particular experiments was a Wimshurst machine with 16-inch glass plates, giving, under good conditions, with the usual small Leyden jars, about 3½ to 4-inch sparks. The usual method of taking pictures with such a machine is to connect the interior coatings of the two jars, respectively, to the positive and negative conductors of the machine, the terminals of the Crookes tubes being connected between the external coatings of the Leyden jars. In this condition the disruptive discharge of the Leyden jars passes through the Crookes tubes and across the balls upon the terminals of the conductors of the machine, the length of spark being regulated by separating the balls in the usual way. This method has been fully described by Prof. Thomson, and is one which I have followed with excellent results.

In experimenting with a fluoroscopic screen of calcium tungstate, it will be noticed that the fluorescence is intermittent and occurs at the time of the disruptive discharge. Finding this fluorescence unsatisfactory, on account of its intermittent character, I was experimenting with an effort to produce a continuous glow, and after various combinations found that

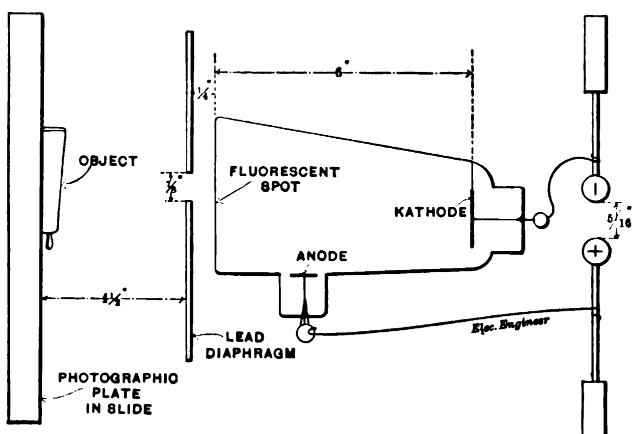


FIG. 1.

with the particular tube that I had then under test a continuous fluorescence could be obtained by connecting the terminals of the Crookes tube directly to the terminals of the Wimshurst machine without the Leyden jars. With this connection the resistance of the vacuum was such that instead of the machine giving the usual continuous violet spark of about two inches in length, the balls had to be brought within a quarter of an inch before sparking would take place.

With the balls removed beyond the sparking point, say three-eighths of an inch or more (the distance being unimportant as long as sparking did not take place), the Crookes tube gave a continuous fluorescence, the fluorescence being produced by the cathode stream, and showing, as usual, a localized spot of considerable brightness at the point upon the glass directly opposite the cathode terminal.

I found that no parts of the tube gave off any rays that could be discovered in the fluoroscope, with the exception of the

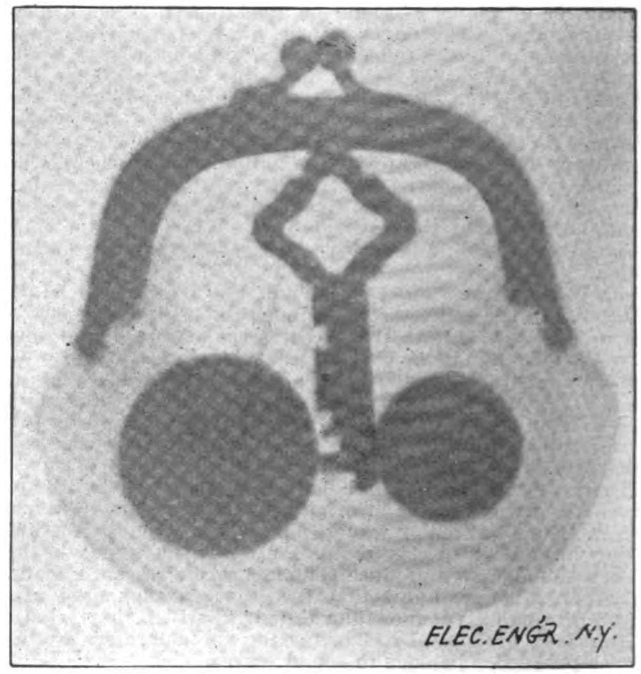


FIG. 2.

bright spot opposite the cathode mentioned above. When the fluoroscope was held close to this pot a bright fluorescence of limited extent was noticed on the screen. Upon removing the screen from four to five inches it became uniformly illuminated with a soft, steady fluorescence, and shadows of the finger and of coins inside of a purse and other well known phenomena were clearly observed. I was greatly surprised at the clearness of the shadows and started immediately to test the photographic powers of the rays, which were evidently being emitted.

The sketch (Fig. 1) shows diagrammatically the conductors of the Wimshurst machine, the general shape and dimensions of the Crookes tube, the disposition of its electrodes and the arrangement and distance of the photographic plate.

I found that good pictures of simple objects could be obtained in twenty to thirty minutes' exposure, and with a lead diaphragm very sharp pictures could be taken in from forty to sixty minutes. The sketch shows a lead diaphragm, with a ⅛-inch aperture, placed about a quarter of an inch below the tube.

Fig. 2 is a silver print of the usual elementary subjects, coins and key within a leather purse, taken under the conditions and with the apparatus above described, using a diaphragm with ⅛-inch opening and an exposure of fifty minutes. During this exposure the terminals of the Wimshurst machine were a little over 5-16 of an inch apart, which was found to be just beyond the sparking limit. In fact, sparking occurred at about a quarter of an inch separation.

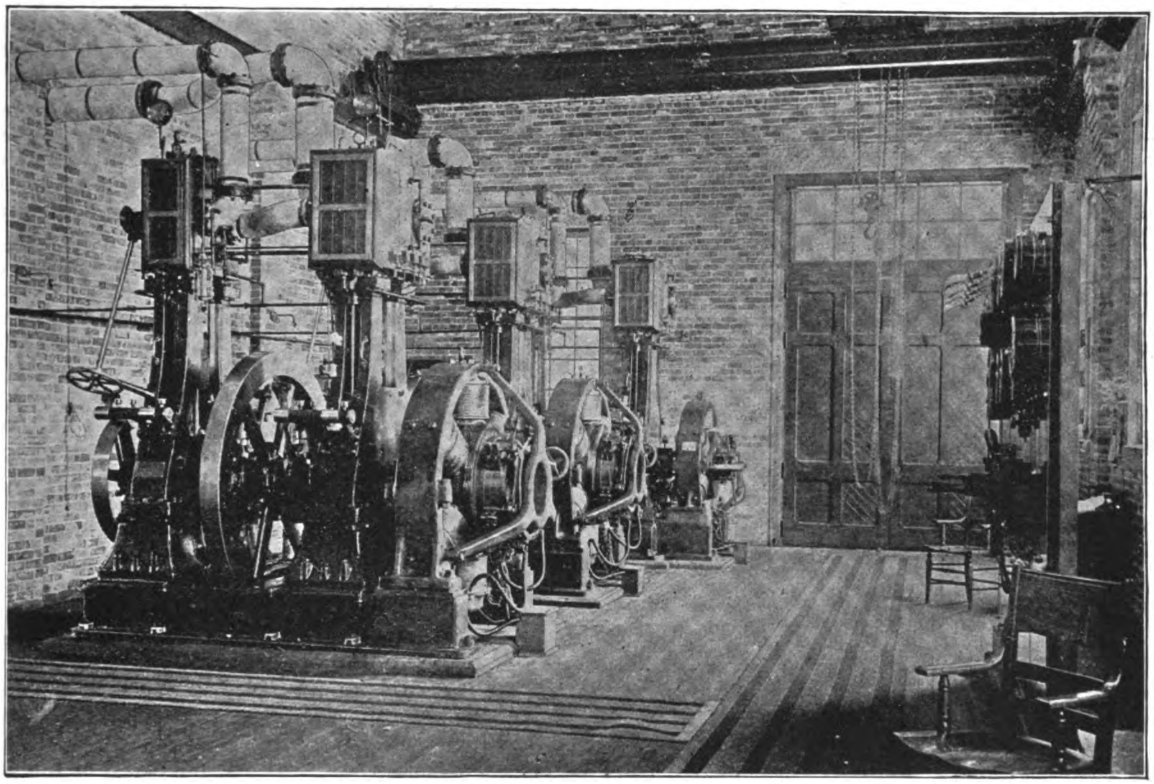
I think that the picture taken shows considerable strength and clearness, and was taken with reasonable rapidity, considering the extremely small potential employed in generating the Röntgen rays. As far as I am aware, the potential was less than has been previously employed with satisfactory results.

I may incidentally remark that I also satisfied myself regarding the matter about which there has been some dispute, namely, the source of the Röntgen ray, as I found that when the fluorescent screen was brought within one inch of the diaphragm referred to, the spot of fluorescent light on the screen was limited; that when moved to about four inches the fluorescence screen, which is 6 x 6 inches, was entirely illuminated. This shows clearly that the rays emanated from the glass, as, if they had emanated from the cathode it would have been necessary to remove the fluorescent screen a much greater distance from the diaphragm before showing a uniform fluorescence. I also could see no indication of fluorescence whatever opposite the anode.

LIGHTING PLANT AT LEADVILLE, COLO.

THE electric lighting plant of the Citizens' Electric Light Company at Leadville, (10,000 feet above sea level), is as thoroughly representative of the latest modern practice in electric lighting as any plant in the East. It is one of the first in this country in which the principle of direct connection has been exclusively adopted and one of the first also operating a very extensive public arc lighting system from incandescent circuits.

Boilers and Engines.—The station occupies a fireproof brick building with iron trussed roof. The boilers are three in number, 60 x 16, horizontal tubulars of 85 horse-power from the works of Brownell Bros., of Dayton, Ohio, and are designed for a working pressure of 140 pounds. Space is left in the boiler room for an additional battery of three boilers. The smokestack is of steel, 4 feet 8 inches in diameter and 90 feet high, set up on four iron columns. Two sets of duplex pumps, each pump of sufficient capacity to operate six boilers, and one National feed water heater complete in boiler-room equipment.



THE NEW THREE-WIRE DIRECT CURRENT, CENTRAL STATION, LEADVILLE, COL.

The three 85 horse-power Lake Erie engines are vertical cross compound, with-cyclinders 7½x13x14 inches. Directly connected to each of the engines is a 50-kilowatt General Electric generator running at 275 revolutions per minute. The third engine has two 25-kilowatt generators of similar type, one on each end of the shaft, running at 300 revolutions. These generators are compound wound, 125-volt multipolar machines with ironclad armatures. During the first two months of the operation of the plant the overload on these dynamos daily ran up to from 25 to 40 per cent., without appreciable heating, while since December, 1895, according to the manager of the station, Mr. G. P. Brown, there has not been a night that all the dynamos have not carried an overload of from 10 to 20 per cent. without experiencing any difficulty.

Switchboard.—The switchboard is of the G. E. central station panel type, 13 feet long by 5 feet high. It is placed well away from the wall to give free access to the back. The conductors are brought to it under the floor and the switches and circuits are so arranged that any dynamo may be operated in conjunction with any other one or more, and on either side of the three-wire system. Two sets of feeders run from the board, and in the event of break down on one set the other may be called into requisition.

Distribution.—The plant is operated on the three-wire system, current being supplied to both arc and incandescent lights and motors. One engine, with the two 25 kilowatt dynamos, is designed to carry the night load from 2 to 5 a. m., the others being cut in as the demand for current requires. By having the generating units thus properly proportioned to the load and capable of being started and stopped at will, great economy of operation is gained, which would not be obtainable by the employment of one or two larger engines. Actual tests on the units installed at this plant showed over 82 per cent., delivered at the dynamo terminals.

The district covered by this system is a little over a mile square, and the lamps at present connected amount to an equivalent of 4,000 of 16 c.-p. There are about 120 arc lamps of the new Thomson type, which have given most excellent satisfaction. The circuits throughout the city are divided into sections, each of which is protected by proper safety devices, so that any trouble occurring on a section will affect that section only.

The main supply circuit consists of an endless circuit, running up the alley west of Harrison avenue, as far as Ninth street, crossing the alley and running down the alley east of Harrison, crossing back again at Chestnut street, making a complete inclosure of Harrison avenue. From this circuit are run the branch circuits supplying consumers east and west. This main circuit is fed at four symmetrical points by the two sets of feeders previously mentioned. The mains consist of three No. 0000 wires. The branches vary in size from No. 4 to No. 0000 wires, with a No. 000 for the neutral. The other feeder consists of five No. 0000 wires.

Since the first month of the operation of this plant the station has been running above its capacity and business has been turned away. The installation of the fourth dynamo relieved the station but temporarily. The company started by supplying current at a flat rate, intending gradually to introduce meters. The majority of consumers now have meters, and the load is gradually falling off, although the income is about the same; this shows the advantages of operating on the meter basis.

The business of the company, as well as the general supervision of the plant, are under the able management of Mr. Geo. P. Brown, with Mr. Richard I. Harrigan as chief electrician. The consulting electricians were Messrs. Shepard and Searing of Denver.

HOOSICK FALLS, N.Y.—The Hoosick Falls Water, Power & Light Company has been formed with a capital stock of $25,000 by G. C. Moses and F. H. Twichell, of Bath, and C. B. Story, F. Riley and G. E. Green, of Hoosick Falls.

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CONTENTS.

ACETYLENE AND CALCIC CARBIDE.

GAS interests at the beginning looked upon the electric light as an enemy to be exterminated at all hazards, and by any means, fair or foul. Yet we believe that the gas fraternity will now admit that nothing has so stimulated the industry as their arch enemy, the electric light. This stimulus has shown itself not only in the constantly increasing gas consumption, but in the improvements in the manufacture and methods of utilization of gas as an illuminant. The Welsbach light may be cited as a case in point. Many were the predictions as to its effect on electric lighting, but thus far we have yet to hear of any marked influence of this illuminant on electric lighting. Indeed instances are not wanting where those who abandoned the incandescent lamp for the Welsbach returned to electricity after a brief trial.

We may defer for the present discussing the reasons which prompted this action, to note the situation in regard to the latest rival of the electric light, acetylene. The announcement that a 5 foot gas burner was capable of giving an equivalent of 240 candle-power was well calculated to put all purveyors of light in an expectant, not to say unhappy, mood, but as time wore on the importance of the brilliancy of the light gave way to the question of the cost of producing it. Calcium carbide, the material from which acetylene is made, as is well known, is a result of the electric furnace, produced by the action of the high temperature of the arc on a mixture of coke and lime. When Mr. Willson accidentally discovered that his aluminum furnace was producing carbide of calcium as a by-product, he naturally turned his energy to the conversion of the by-product into the main product of his furnace, and thus it has come about that until lately the main supply of calcium carbide was obtained from Spray, North Carolina. More recently a carbide factory has been erected at Niagara Falls, but as will be shown presently we may well take the Spray works as representing a very fair example of such an establishment.

The cost of acetylene, that is, carbide of calcium, must evidently determine the ultimate success or failure of the illuminant, and the figures quoted for the carbide have varied all the way from $10 to $60 per ton. It was therefore a commendable stroke of enterprise which prompted our contemporary the "Progressive Age" to send a commission to the works at Spray, to investigate and report upon the processes in use there and the cost of producing the carbide in ton lots. This commission, consisting of Messrs. Houston and Kennelly, as electrical experts, and Dr. L. P. Kinnicutt as chemist, have completed their report, which is published in full in our contemporary, and from which we extract a few figures for comment.

According to the report of the commission's investigations "the cost of producing calcium carbide at Spray, by working the furnaces 365 days a year, and 24 hours a day, yielding on an average one ton of 2,000 pounds gross carbide a day, is $32.767 per ton. Of this amount $14.39 is for material. The freight charges on lime and coke are heavy at Spray, and add materially to the cost." We have quoted the commission's report in the above in order to put the matter squarely on record in their own words.

Let us see how this figure is arrived at. In the schedule entitled "Cost of Manufacturing Plant" the item of "Land," upon which the buildings are erected is put down as $100, out of a total of $11,955 for the entire cost value of the plant. This is certainly a low figure and it seems hardly probable that it could be duplicated in other localities combining similar advantages as regards power facilities, such as at Niagara. Next we come to the item of labor, which is given as follows in the report.

Superintendent at $4 per day	$4.00
Three squads of men, 8 hours each	7.00
	$11.00

We consider this figure very low, but pass on to the item

of power. This is given as $5 per horse-power per annum at the turbine. We are certain that nowhere could power be obtained more cheaply, and that that figure would only be reached in a plant employing many thousands of horse-power—if situated at Niagara, for example. If we take into consideration, therefore, the low cost of power, labor, land, etc., at Spray, and especially the fact that the works are run continuously, day and night, including Sundays, it may be fair to assume that the increased cost of material is balanced by the above favorable conditions; so that $32.76 may be considered a fair figure for calcium carbide per ton.

In a table published in the "Progressive Age," on the assumption of $40 as the price of a short ton of calcium carbide, acetylene gives 9,600 candle-hours per $1, or, converting to $32.76 per ton—11,740 candle-hours per $1. By the same table we notice that the Welsbach burner, with gas at $1.65 per 1,000 cubic feet, gives 12,121 candle-hours per $1, thus putting acetylene below the latter in commercial value. This is hardly encouraging for the advocates of acetylene, and if its use be confined even to enriching other illuminating gases, its demonstrated cost must practically make its use prohibitive.

Messrs. Houston and Kennelly supplement their main report by a calculation of the probable cost of the carbide, if the plant were a large one—1,200 horse-power being assumed—with power at $5 per annum, works operating 300 days per year, and coke $2.75 and lime $2.50 per ton, respectively. With these conditions obtaining, they arrive at the figure $20.04. Such a plant would require an investment of $44,700 and would produce only 1,500 tons of carbide, costing $30,062, evidently a small manufacturing output for so large an investment. If to the $20.04 there be added the cost of business administration, and a profit of, say, 15 per cent., this figure would be materially increased. To this must be added the cost to the consumer of the freight charges, which would probably be quite as high, as calcium carbide is bulky for its weight. It may be argued that the acetylene may be compressed and liquefied at the works, but in that case the cost of compression would amount to a respectable percentage of the freight bill of the carbide in bulk.

With these figures before us, which are probably as favorable to the cause of acetylene as they could be fairly made, there would appear to be little to be feared from that source, so far as electric lighting is concerned. But even if the showing were more favorable, the fact that acetylene is a gas, with all the faults, and some added ones, of coal and water gas, must always militate against it as compared with the healthful and cool incandescent and brilliant arc. It would, of course, be useless to deny to acetylene any commercial value whatever, for we believe that it has large and remunerative fields open to it; but as a competitor for general illumination it can hardly yet be said to be reduced to a commercial basis.

THE RELATIVE COST OF ELECTRIC AND STEAM POWER.

It may be considered a bold statement that not one steam user in a hundred knows just what his power is costing, and this relates probably as much to the large as to the small steam user, though the latter, of course, is more apt to be at sea on this important item of cost in manufacturing or current generating purposes. That the assertion above made is fairly accurate must be apparent by the varying figures one sees quoted as coming from steam users, the majority of whom usually fail to take into consideration items which properly belong in the category of steam engine operation. This question, however, is of increasing importance, now that numerous water powers are being transmitted to manufacturing centers, and any light that can be shed on it will aid materially in placing the matter correctly before power users. That the interest in the subject is a live one is shown by several communications we have received asking for an explanation of what is meant by Dr. Charles E. Emery in his note in our issue of April 8, wherein he states that Mr. H. A. Foster in reporting cost of steam power by the horse-power year, instead of the horse-power hour, "not only deceived himself, but many others." Dr. Emery, to whom the inquiry was forwarded, responds that he will explain the matter fully later, but that the principle will be understood by the following illustration: If ordinary 10-hour steam power costs $30 per year, 24-hour steam power for the same number of days in the year would cost $72 per year, and for variable power each average horse-power would cost $72 per year; but if the number of horse-power hours for variable power only equaled those for ten hours at a maximum power, the number of average horse-powers would be only 10-24 times the number of maximum horse-powers, and the yearly cost for the whole power be the same as for the maximum horse-power on a 10-hour basis, or at the rate of $30 per year. The charge for water power must be for maximum horse-power, and therefore must compete with steam power on the same basis. Such charges must therefore be compared with the $30 per horse-power year and not the $72. Mr. Foster only gave the higher prices in the article referred to (Electrical Engineer, June 26, 1895), which it would therefore seem are not applicable, and concluded his presentation by the sentence: "The general result as shown by the above table is that steam power is costing much more than the users, or, in fact, engineers in general, have heretofore estimated." A different result would have been shown if his comparisons, instead of being on a horse-power basis, had been derived from the horse-power hours substantially as above stated.

THE VARIETY OF THE EXPOSITION.

ENOUGH data with regard to the coming National Electrical Exposition in this city have appeared to show that it will possess a variety of attractions going even beyond the plans of those who originally projected it. It will, indeed, be fairly and generously representative of all the electrical arts, for it is hard to think of a branch that will not be included in some interesting form or other.

Although held under the auspices of the National Electric Light Association, the Exposition is very far from being restricted to the field that was covered by the Association when it was founded. As a matter of fact, the Exposition will accentuate, and direct attention to, the remarkable fact that central stations are rapidly undergoing evolution, and that every day they become less and less plants for mere lighting, and more and more reservoirs for the supply of current for a wonderfully wide range of uses, many of which are barely yet known.

Looking, moreover, over the long list of exhibitors, one is struck again with the fact that the "independent" companies are so numerous, so strong and so energetic. It is true that the General Electric-Westinghouse combination will have fine displays, but they will be relatively insignificant, both in scope and quantity and in the resources exhibited, as compared with the multitudinous displays of some 150 concerns all building apparatus or supplies for the open market. In fact, if both of the largest concerns were unrepresented, the show would still remain rounded, complete, and an adequate presentation of everything that a purchaser can need who wishes to enjoy the modern facilities and conveniences of electricity. Both companies will of course have fine and interesting exhibits, but with so many young and keen rivals around them, the truth will appear which we have already urged, viz. that they have no monopoly and cannot secure one, but that their business success must rest upon the merit of their goods. If any manufacturer thinks that either of these great concerns will be satisfied to rest supine under the ægis of a mass of patents and will not try to win by cheapness and superiority, we fear he is likely to be mistaken.

All things considered, both in the scope of its displays and in the stimulus it gives to another period of prosperity in the electrical industries, the Exposition seems destined long to be memorable.

TELEPHONY AND TELEGRAPHY.

ON TELEPHONIC DISTURBANCES CAUSED BY HIGH-VOLTAGE CURRENTS.[1]—II.

BY DR. V. WIETLISBACH.

The telephonic disturbances most difficult to deal with are those considered under III., i. e., those due to induction. The most effectual means of combating this class of disturbance consists in doubling the telephone conductor, the two wires being placed as closely as possible to each other, and the telephone apparatus at each terminal being inserted between them.

A high-voltage line in proximity to the double telephone line will produce in each of the two wires a disturbing current which will flow to the same terminal, where both currents compensate each other; no disturbance will, therefore, be noticeable in the telephone apparatus. When the disturbing cause is not of excessive magnitude, this remedy will give satisfactory results. But when, on the other hand, the value of the disturbing current is several hundred or several thousand times greater than that of the normal telephone current, the remedy must of necessity fail. In that case corresponding precautions are required also in respect of the high-voltage line, i. e., the latter must, like the telephone line, be provided with a metallic return, the two wires being placed in close proximity to each other, and requiring, moreover, a very high degree of insulation. Currents of approximately equal amount will then flow in both the high-voltage wires in opposite directions, and the same will apply to currents which are thereby induced in the telephone line, and which will, therefore, virtually neutralize each other.

Thus, in respect of the difference of induction, a twofold effect is obtained: one between the high-voltage, and another between the low-voltage wires; and it only remains to place the two lines at such a distance apart from each other as will ensure the noise being sufficiently deadened. This distance is obviously governed by the parallel length of the two lines and by the nature of the inducing high-tension current. In order to get rid of the noise altogether the two pairs of wires should, moreover, be placed in a properly-defined reciprocal position. Suppose the wires 1 and 2 to form the high-voltage circuit, and the wires 3 and 4 the low-voltage circuit, and suppose r_{13}, r_{23}, r_{14} to be the distances between them, the equation for reducing the inductive effect to 0 is—

$$r_{13} \times r_{24} = r_{23} \times r_{14}.$$

In practice, however, this result can only be obtained approximately. The complete metallic circuit gives satisfactory results only when the insulation is perfect at all points, and the two component parts are electrically and in every respect perfectly symmetrical. This desideratum is attainable in short telephonic lines, but to permanently maintain this perfect condition in telephone lines extending over hundreds and thousands of kilometres, is a practical and technical impossibility.

This is obvious from the following considerations: When at the terminal of a telephone line of, say, 500 kilometres (312 miles) in total length, a high-voltage current line runs parallel to the telephone line for a few hundred metres, a single point of defective insulation, e. g., the contact with the branch of a tree at the whole terminal, suffices to immediately produce along the whole telephone line a noise so marked as to render telephonic communication absolutely impossible. Nor is this all. When the noise is sufficiently violent it spreads to all the other telephone lines which use the same poles as the disturbed line for part of the total length of the latter.

When, for example, a slight defect occurs in the telephone line from Zurich to Geneva, the noise produced by a high-voltage installation, e. g., the electric tramway in Zurich, spreads not only from Zurich to Geneva, but makes itself more or less felt in all lines which, for part of the distance, use the same poles. Hence the noise is perceptible also at Lausanne, Berne, Fribourg, Neuchatel, Bienne, Chaux-de-Fonds, Basle, and generally throughout the telephonic system of Western Switzerland. Under unfavorable circumstances, i. e., when the noise is particularly violent, it may even, by secondary or tertiary translation, spread from the Zurich and Geneva line to the Berne and Basle line, thence to the Basle and Bienne line, and thence to the Bienne and Chaux-de-Fonds line at the points where Basle-Bienne runs parallel, not to Zurich-Geneva, but only to Berne-Basle, and again, where Bienne-Chaux-de-Fonds runs parallel only to Bienne-Basle.

This phenomenon is one of the most difficult to deal with, and is, as a rule, not sufficiently taken into account. The telephone system of Switzerland now comprises a total wire length of about 60,000 kilometres (37,500 miles)[1], and it is therefore obvious that the task of maintaining so large an aggregation of lines at all points in faultless condition is by no means an easy one. In many cases the only way to obtain a fairly satisfactory result is to bury the specially exposed or affected sections of a telephone line underground; but it is not worth while to incur the trouble and expense which that operation involves, unless a large number of telephone wires can be buried at the same point and at the same time.

A further remedy consists in translators, which correspond to the transformers of high-tension installations, and which connect two sections of a telephone line electrically by electro-magnetic induction, but at the same time prevent the injurious effect of a fault in the line, e. g., leakage to earth, abnormal resistance, etc., being transferred from one section to the other. The effective capacity is, by this means, also lessened. When, e. g., the telephone sections Zurich-Berne and Berne-Geneva are connected by a translator at Berne, any leakage which may take place in Geneva does not affect the Berne-Zurich section. The efficiency of translators does not, however, exceed 90 per cent., and, though they furnish a means of restricting the effect of a telephonic disturbance to a given section of the entire line, they involve, on the other hand, a loss of energy.

Other remedies, such as a differential arrangement of wires, Muller's method of running the wires, etc., can only be regarded as of minor importance; for though they may render valuable service in special cases, they are not suitable for general application.

The noise produced in the telephone by a disturbance varies, of course, greatly in degree, and depends essentially on the amount of the high-voltage current and on the parallel length of the high and low-voltage lines. Where the high-voltage line is well insulated from earth, and the wires constituting the high-voltage circuit run parallel to each other, it is, in the majority of cases, and particularly in conjunction with the metallic return, also of the telephone line, practicable to place the two lines in juxtaposition for short distances not exceeding a few hundred metres, even in the same street. But when the parallel length extends over one kilometre or more, the noise may be distinctly observed, even though the two lines be as much as 100 metres or more apart. It would seem that the configuration of the ground, too, may exert a certain influence. When the high-voltage line, e. g., that of an alternating current installation, is insufficiently insulated, or, what is worse, is connected to earth, a single crossing of the telephone line, even though it be at right angles, suffices to produce in the telephone a humming disturbance of a very marked character.

Conspicuous among high-voltage installations connected to earth are the majority of electric tramways. As a rule, these tramways are worked with continuous current, which is, however, by the motion of the motor cars converted into a pulsating one. And since the current is conveyed only by one wire, and the compensating effect of the metallic return is wanting, the telephonic disturbance is much greater in proportion. In Switzerland there is only one electric tramway, which, instead of using earth, i. e., the rails as return, has a complete metallic circuit constituted by two overhead wires, to-wit, the Vevey Montreux-Chillon tramway. The effect of the working of this tramway upon the telephone line running along the same road is noticeable where that telephone line is only single with earth return, but the slight noise disappears almost entirely where the same telephone line has two wires.

All the other electric tramways so far constructed in Switzerland use only one conductor, which is suspended above the rails, and from which the continuous current is conveyed either by trolley wheel or by slide contact to the motors of the cars, whence it passes through the car frame and wheels to the rails, and through the latter is intended to flow back to the generator. The rails are generally imbedded in the roadway, and more especially in wet weather insulation is either defective or is wanting altogether, the insulating resistance being only 15 to 20 ohms per kilometre. Hence, a more or less large proportion of the current spreads through earth or straggles back to the generator by water and gas pipes, or by telephone wires, the telephone lines connected to earth being thereby subjected to the intrusion of the high-voltage tramway current. In order to obviate this, the rails should be insulated from earth as well as possible, and that might be accomplished by imbedding them in cement or asphaltum. Experience tends apparently to show that where the permanent way is imbedded in wood pavement, the loss of current is greatly mitigated.

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[1] This is equal to 20 kilometers (12.5 miles) per 1,000 inhabitants.—TRANSLATOR.

Electric Transportation.

CAN ELECTRICITY SUPPLANT THE STEAM LOCOMOTIVE ON TRUNK RAILWAYS?—IX.

BY

Wm. Baxter, Jr.

If the power of a locomotive is limited, then the horizontal effort it can develop is inversely proportioned to the velocity. Calling the power P and the horizontal effort F we would have

$$F = \frac{P}{V}.$$

Calling the total resistance of the train R we would also have

$$F = R.$$

Now R is the sum of two resistances, the tractional resistance and the atmospheric resistance. Calling these R_1 and R_2, respectively, we would have

$$R = R_1 + R_2 = F = \frac{P}{V}.$$

The atmospheric resistance R_2 is a quantity very difficult to ascertain, but for the purpose of a comparative estimate it matters little whether the value assumed is rigorously correct or not. According to the experiments of Mr. O. T. Crosby, on atmospheric resistance, the variation is proportional to the velocity for speeds within practical limits.

This is not in accordance with the theory that has been accepted heretofore, which is, that resistance of gases and liquids increases as the square of the velocity. But Mr. Crosby's experiments were quite extensive and carefully made, and furthermore, agree more closely with observed facts than the older theory. Therefore it would seem that calculations based on his results would be more accurate. Proceeding on this basis we can assume that the atmospheric resistance to a train is equal to the resistance on an area normal to the line of motion. We would then have $R_2 = AVC$, where C represents the pressure at unit velocity and A the total area. We could deduce C from the figures given by Mr. Crosby and others, but I believe more accurate results can be obtained by taking them from the actual performance of the Empire State Express in the following manner:

Take the power developed at, say, 70.5 miles, that is, 1,059 horse-power = 34,947,000 foot-pounds per minute, and this divided by 70.5 x 88 (88 being the number of feet per minute for a speed of one mile per hour), gives 5,649 as the horizontal effort, friction not being deducted. According to the best authorities, the friction of a locomotive ranges from 5 to 10 per cent. Ten is undoubtedly too high, but on the other hand five looks very low. If we take it at 6 per cent. we would have

$$5{,}649 \times .94 = 5{,}310 = F = \frac{P}{V}.$$

The weight of the train from which the data in Table 10 were obtained was 270 tons. The tractional resistance of such trains on good steel rails is conceded to be about six pounds per ton, and on this basis the value of $R^1 = 270 \text{ x } 06 = 1{,}620$ pounds; and R_2 would be equal to

$$\frac{5310 - 1620}{70.5} V = 52.34 V.$$

From the foregoing we obtain

$$V = \frac{P}{F} = \frac{P}{R_1 + R_2} \quad \text{.......... ....(1)}$$

$$R_1 = \frac{P}{V} - R_2 \quad \text{.......... .... (2)}$$

$$R_2 = \frac{P}{V} - R_1 \quad \text{.... .... (3)}$$

$\frac{R_1}{6}$ = weight in tons that the locomotive can draw.

From these equations the results given in Table 11 have been obtained. As will be noticed the figures are given for a locomotive capacity of 1,059 and also for 1,250 horse-power.

From the data in Table 10 it is fair to assume that the maximum capacity of the locomotive from which the figures were obtained is about 1,060 horse-power, and this amount of power, as shown in Table 11, would draw a train of about the weight of the Empire Express at the rate of about seventy miles per hour on a level track. If a locomotive can be built that will give a continuous output of 1,250 horse-power, it would draw the same train at a speed of 80 miles per hour. These figures may be disputed in view of the fact that speeds of over one hundred miles per hour have been recorded; but it must be remembered that the results were obtained on short spurts of two or three minutes' duration, which is a very different thing from a sustained run.

It is possible by starting with a very bright fire and an extra high pressure of steam to develop an amount of energy

TABLE 11.

Capacity of Steam Locomotives at Different Speeds.

	P = 1059 Horse Power.					P = 1250 Horse Power.				
Miles per hour, V.	Horizontal effort, $F = \frac{P}{V}$.	Atmospheric resistance = R_2.	Force available for drawing load $R_1 = \frac{P}{V} - R_2$.	No. of tons that can be drawn. $\frac{R_1}{6}$.	No. of tons in addition to locomotives.	Horizontal effort, $F = \frac{P}{V}$.	Atmospheric resistance = R_2.	Force available for drawing load $R_1 = \frac{P}{V} - R_2$.	No. of tons that can be drawn. $\frac{R_1}{6}$.	No. of tons in addition to locomotives.
60	6,222	3,140	3,082	513	413	7,812	3,140	4,672	778	678
70	5,333	3,663	1,670	278	178	6,696	3,663	3,033	506	406
80	4,667	4,186	481	80	....	5,859	4,186	1,673	279	179
90	4,149	4,710	....	....	....	5,208	4,710	498	83	....
						4,687	5,233	......	....	....

considerably beyond the actual capacity, and thus for a short time obtain a very high speed, but the extraordinary strain on the boiler under such conditions would soon reduce the pressure and the spurt would come to an end. I believe that it is perfectly safe to say that the most powerful locomotives in use could not maintain a speed greater than 70 miles per hour on a level track with a train weighing, including engine, 270 tons.

Now let us see what electric motors could do. As already stated, the maximum torque of a motor can be obtained at any speed. It must not be understood by this that any given motor will pull just as much at one velocity as at another, for such is not the case. If it is wound to give the maximum torque at 60 miles per hour its pulling capacity will drop very rapidly as soon as this speed is exceeded; but if the motor is wound for any given speed it will give its maximum torque at that speed. Table 12 shows the loads that electric motors would draw at different speeds, and it is based on the assumption that the motors are wound to give the maximum torque at each speed given in the table.

It has already been shown that the energy output of an electric motor is not limited, practically, because it has the entire power station behind it; therefore the horizontal effect, instead of being equal to power, divided by velocity, is equal to a constant, and the numerical value of this constant is only limited by considerations of economy. In the table the horizontal effort has been taken at 6,222 pounds and also at 10,000 pounds. The first figure has been taken, because it is the same as that of the locomotive in Table 11 for 60 miles per hour, and thus the figures for succeeding speeds show us at a glance the advantages of electric motors over steam. The other figure, that is, 10,000, has been taken to show what speeds are possible with electric motors. As to the possibility

TABLE 12.

Capacity of Electric Motors at Different Speeds.

Miles per hour.	Horizontal effort, F.	Atmospheric resistance, R_2.	Force available for drawing load. $R_1 = F - R_2$.	No. of tons that can be drawn. $= R_1/6$.	No. of tons in addition to motors.	Horizontal effort, F.	Atmospheric resistance, R_2.	Force available for drawing load. $R = F_1 - R_2$.	No. of tons that can be drawn $= R_1/6$.	No. of tons in addition to motors.
60	6,222	3,140	3,082	513	488	10,000	3,140	6,860	1,143	1,113
70	6,222	3,663	2,559	426	401	10,000	3,663	6,337	1,056	1,026
80	6,222	4,186	2,036	339	314	10,000	4,186	5,814	969	939
90	6,222	4,786	1,436	239	214	10,000	4,786	5,214	869	839
100	6,222	5,233	989	165	140	10,000	5,233	4,764	794	764
110	6,222	5,757	465	77	52	10,000	5,757	4,243	707	677
120	......	......	......	....	....	10,000	6,280	3,720	620	590
130	......	......	......	....	....	10,000	6,804	3,196	532	502
140	......	......	......	....	....	10,000	7,327	2,673	442	412
150	......	......	......	....	....	10,000	7,851	2,149	357	328

of obtaining a horizontal effort as high as this figure there is no room for doubt. It is already a matter of record that the electric locomotive in the Belt line tunnel in Baltimore can develop a drawbar pull far beyond this amount.

The figures in this table show that motors giving a horizontal effort of 6,222 pounds could draw cars weighing 140 tons at a speed of 100 miles per hour. And this is a weight only thirty tons less than the Empire State Express, exclusive

of locomotive. We also see that with a horizontal effort of 10,000 pounds a train weighing 358 tons could be drawn at a speed of 150 miles per hour. These results look startling, but if we investigate further we will find that 10,000 pounds at 150 miles per hour equals 4,000 horse power.

It is not at all certain that even 4,000 horse-power would draw a train of such weight at a speed of 150 miles per hour. This estimate is based on the supposition that the atmospheric resistance increases directly with the velocity, and although the experiments of Mr. Crosby go very far toward demonstrating that this is the true relation there is still a great deal of room for doubt.

But outside of the question of power, there are other things that have to be taken into consideration. The wear and tear at such a velocity would be largely increased, not only on the rolling stock, but also on the roadway, and the increased expense in this direction might be enough to render such speed prohibitive.

It may be of interest, therefore, to know to what extent speed can be increased, without increasing the cost of coal consumed per hour. As this increase would not be so very great we can assume that its effect on wear of road and rolling stock would not be serious.

As has already been shown, the cost of coal per horse-power delivered on the track is about half as much for electricity as for steam; therefore, twice the power can be used at the same expense. We will then assume that electric motors of 2,100 horse-power would cost the same to operate (so far as cost of coal is concerned)) as the locomotives that draw the Empire State Express. We can then by means of equation (1) determine the speed that could be made, as follows:

$$V = \frac{P}{R_1 + R_2} \text{.......} \quad \text{............}(1)$$

$P = 2100$ h.-p. $= 69{,}300{,}000$ foot-pounds per minute.

$R_1 = 270 \times 6 = 1{,}620.$

$R_2 = .594\,V = \frac{52.34\,V}{88} =$ head resistance at one foot per minute.

$$V = \frac{69{,}300{,}000}{1620 + .594\,V}.$$

Multiplying both factors by (1620+.594 V,
V (1620+.594 V)=69,300,000.

Also, $.594\,V^2 + 1620\,V = 69{,}300{,}000$. Whence, $V^2 + 2727.27\,V = 166{,}666{,}666$, and $V = -\,1363.63 \pm \sqrt{116{,}666{,}666 + (1363.63)^2} =$ 9522 feet per minute= 108 miles per hour.

This result shows that with the same expenditure for coal that is required in a steam locomotive to maintain a speed of 70 miles per hour with a train of the weight of the Empire State Express electric motors could make a speed of 108 miles per hour.

These figures are just as favorable as they can be made for steam. The weight of train has been taken at 270 tons, whereas it should not be over 200 if the motors are assumed to be mounted on the trucks of one of the cars. But in order not to be charged with unfairness by those who may insist that a separate motor should be used, the weight has been left high enough to permit of such an arrangement.

The foregoing shows that much higher speed is possible with electric motors than with steam locomotives, from the fact that the former can be made of much larger capacity; but when the construction and action of the locomotive is taken into consideration it will be found that, aside from the inability to develop the necessary energy, there are mechanical obstacles that limit its capacity.

The moving plant of a motor rotates, and, if properly balanced, there is no limit practically to its velocity; but on a locomotive the moving parts reciprocate, and therefore the velocity is limited. A locomotive to make a speed of 80 miles per hour would have to make about 350 revolutions per minute, which would give a piston speed of about 1,460 feet. Such a velocity in a stationary engine would be considered far beyond practical limits. What is usually called a high-speed engine is one in which a piston velocity of from 500 to 600 feet per minute is attained. Now if this is high for a stationary machine it certainly should be high for a locomotive. Nevertheless the latter runs at more than double this velocity, and this fact no doubt accounts for the enormous wear and tear. It has been proposed to overcome this difficulty of high rotative velocity by increasing the diameter of driving wheels. This would relieve the machine to a certain extent of the strain that it would be subjected to with smaller wheels, but it would not render much higher speed possible, because then the ability of the boiler to furnish the necessary supply of steam would limit the capacity. It may be conceded that locomotive boilers have not yet reached their utmost capacity and that it is possible to obtain still greater evaporation, but it must be admitted that no very great increase is possible; therefore much higher speed than is now made cannot very well be expected.

ELECTRIC CHAISE FOR QUEEN VICTORIA.

"Invention" says that an electric chaise was ordered by the late Prince Henry of Battenberg for Queen Victoria. The vehicle, which is not yet finished, is built upon a double framework of tubes with a head tube for steering, such as a bicycle has, the steering handle being somewhat like that used in Bath chairs. The body of the carriage is composed of aluminum, and it runs upon three wheels, fitted with Michelin tires; the propelling force is a dynamo driven with Fulmen accumulators.

THE WOOD AND MILLER SAFETY CONTROL DEVICES.

A patent has just been granted to W. M. Wood and J. C. Miller, of Elmira, N. Y., for an invention designed to stop the cable of a cable railroad from the platform of a car at any point of the road, by forming an electric contact, sending the current to the power station and throwing out the clutch that connects the cable drum with the main shaft, or stopping the engine. It affords quick and positive means within the reach and control of the motorman to stop the cable in case of his inability to detach the grip from the cable and prevent the loss of life, limb and property. Messrs. Wood and Miller have invented several safety appliances for stopping engines, machinery, etc. Another invention of these gentlemen, which is especially adapted to electric-power houses, is one whereby an engine will stop itself automatically in case of racing or increase of speed to a dangerous degree, and will also throw out a circuit-breaker or switch and cut out the current from the dynamo, and prevent motoring by other dynamos connected on the line. About six months ago Messrs. Wood and Miller placed one of their engine stops and auxiliary governors in the factory of J. Richardson & Co., at Elmira, by means of which the factory engine will stop itself in case of racing, and can also be stopped by merely pushing a button from any part of the building. On March 25 a test of this machine was made, after six months' usage, and found in perfect working order. The auxiliary governor is both electrical and mechanical in its construction. The engine was raced by cutting out its governor, and was stopped electrically. The electric wires were then cut out and the engine stopped by the mechanical device. The test was highly satisfactory to Messrs. Richardson & Co., as well as to the inventors. The Elmira Safety Appliance Company have secured control of the inventions, and are now ready to manufacture and place them on the market.

A TUG TO BE FITTED UP WITH APPLIANCES FOR TRANSMITTING POWER.

The Alaska "Searchlight" contains the outlines of a novel scheme on foot for developing the mineral belts of Alaska adjacent to the coast. The author of this scheme is W. F. Mills, who is largely interested in Alaska mining property.

The proposition is to fit up a tug of about thirty tons burden with electric attachments consisting of dynamos, two or three miles of insulated wire, and a diamond drill with attachments for boring about 300 feet. Power will be supplied from the tug to operate the drill. All of the attachments will be made in sections weighing not more than seventy-five pounds each, so that they can be easily packed from tide water to the base of operations. The tug will carry a crew of about ten men. In most places, if necessary, Indians will be employed to do the packing. Part of the crew will be engaged in supplying the fuel necessary, which is plentiful in any locality in Alaska. While the drill is being sunk in one location men will be sent ahead to prospect for another, so that the drill will be kept in constant operation, showing just what the ledges operated upon contain. The drill will bore from twenty to forty feet per day, which will be a rapid way of testing the different mineral belts, of which there are many throughout Southeastern Alaska. Admiralty Island alone, if properly developed, should furnish enough ore to keep 10,000 stamps going constantly for an indefinite period.

THE KINGS RIVER ELECTRIC POWER COMPANY has been formed at Reedley, Cal., with a capital stock of $360,000. The directors are S. T. Earl and J. S. Jones, of Reedley; J. Sibley, of Dinuba, and C. G. Wilcox and W. S. Hammond, of Visalia.

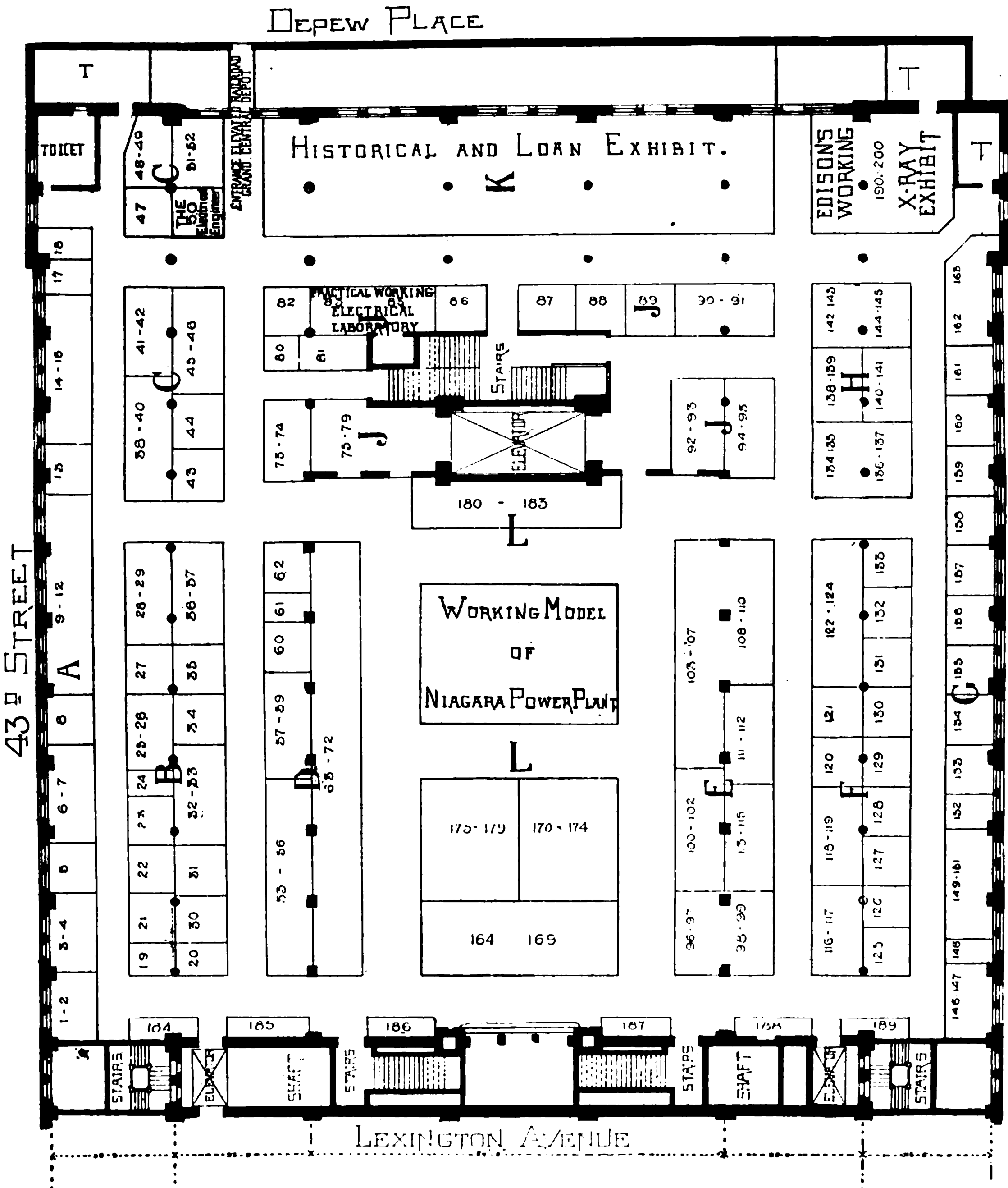
Exhibition Notes.

WHERE EXHIBITORS WILL BE LOCATED.

THIS week we are enabled to publish a preliminary plan of the main floor of the National Electrical Exposition, showing the location of exhibitors there, as far as at present arranged. In addition to this floor there is also the ground floor, where the boiler plant of 1,200 horse-power and some 12 or more engines and dynamos will be found in combination, each of the 12 engines having its own specific dynamo to drive. It is said that this in itself will be the finest display of direct driven apparatus ever made, and will show how far that tendency has gone.

The key to the plan herewith gives the letter and space number for each exhibitor, and thus locates about one-half of those who will be represented at the exposition. Other allotments of space are being made as rapidly as possible:

Adams-Bagnall Electric Co., Cleveland, O., B. 28-29.
American Electric Heating Corporation, Boston, Mass., B. 60.
Anchor Electric Co., Boston, Mass., G. 155.
American Watchman's Time Detector Co., J. 87.
Birdsall Electric Manufacturing Co., New York, A. 17.
Bishop Gutta Percha Co., New York, A. 5.
Bossert, Wm. F., Utica, N. Y., G. 148.
Boynton Multivolt Battery Co., New York, H. 140.
Bradford Belting Co., Cincinnati, O., G. 146-147.
Bryan-Marsh Co., New York, F. 116-117.
Burry, John, New York, J. 80.
Buyers' Reference, A. 18.
Calculagraph Co., New York, F. 131.
Card Electric Motor and Dynamo Co., Cincinnati, O., D. 62.
Carpenter Enamel Rheostat Co., Hoboken, N. J., G. 156.
Chapin-Douglass Electric Co., New York, B. 23.
Clark Electric Co., New York, B. 35.



PLAN OF MAIN FLOOR, NATIONAL ELECTRICAL EXPOSITION.

Columbia Rubber Works Co., New York, F. 128.
Columbia Incandescent Lamp Co., St. Louis, Mo., 594-595.
Crocker-Wheeler Electric Co., New York, L. 175-179.
Crouse-Tremaine Carbon Co., Fostoria, O., B. 30.
Cutter Electrical Manufacturing Co., Philadelphia, Pa., H. 138-139.
Dale, Farrell & Co., New York, F. 130.
DeVeau & Co., New York, D. 185.
Diehl & Co., Elizabethport, N. J., F. 118-119.

Dixon, Jos., Crucible Co., Jersey City, N. J., F. 126.
Empire Self-Lighting Oil Lamp Co., E. 112.
Edison Electric Illuminating Co., New York, D. 63-72, J. 75-79.
Electric Storage Battery Co., Philadelphia, Pa., D. 53-56.
Electrical Engineer, The, New York, C. 50.
Electrician Publishing Co., Chicago, Ill., C. 48-49.
Electricity Newspaper Co., New York, C. 47.
Electrozone Co., New York, H. 142-145.
Excelsior Electric Manufacturing Co., E. 111-113-115.
Ferracute Machine Co., Bridgeton, N. J., G. 152.
Forest City Electric Co., Cleveland, O., B. 27.
Fort Wayne Electric Corporation, Fort Wayne, Ind., B. 25-26.
Gamewell Fire Alarm and Telegraph Co., New York, J. 73-74.
General Electric Co., Schenectady, N. Y., L. 180-183.
Gordon-Burnham Battery Co., New York, G. 157.
Hall, George P., & Son, New York, B. 184.
Holtzer-Cabot Electric Co., Boston, Mass., F. 125.
Huebel & Manger, Brooklyn, N. Y., E. 188.
India-Rubber and Gutta Percha Insulating Co., Yonkers, N. Y., A. 67.
Interior Conduit and Insulation Co., New York, E. 103-110.
Iron-Clad Rheostat Co., Westfield, N. J., G. 153.
Johnston, The W. J., Co., New York., C. 51-52.
Keuffel & Esser Co., New York., J. 90-91.
Lozier, R. T., New York, D. 62.
Metropolitan Telephone and Telegraph Co., New York., E. 96-99.
Mica Insulator Co., New York, F. 127.
National Carbon Co., Cleveland O., B. 22.
National Conduit Manufacturing Co., New York., B. 32-33.
New York Carbon Works, New York., H. 141.
Niles Tool Works Co., Hamilton, O., H. 134-137.
Nowotney Electric Co., Cincinnati, O., F. 121.
Okonite Co., New York., A. 1-2.
Osterberg, Electrical Laboratory, J. 83-85.
Partrick & Carter Co., Philadelphia, Pa., G. 161.
Pass & Seymour, Syracuse, New York, G. 154.
Pennsylvania Slate Co., New York., D. 59.
Peck Electrical Co., New York, J. 82.
Peru Electric Manufacturing Co., Peru, Ind., F. 129.
Reisinger, Hugo, New York, G. 149-151.
Roebling's Sons, John A., Co., New York, A. 3-4.
Russell & See, New York, J. 88.
Safety Insulated Wire and Cable Co., New York, A. 9-12.
Schiff, Jordan & Co., Vienna, Austria, C. 40.
Schoonmaker, A. V., New York, F. 189.
Spon & Chamberlain, New York, J. 86.
Sprague Electric Elevator Co., New York, F. 122-124-132-133.
Standard Paint Co., New York, C. 38-39.
Standard Underground Cable Co., Pittsburg, Pa., A. 13.
Stanley Electrical Mfg. Co., Pittsfield, Mass., E. 100-102.
Stanley & Patterson, New York, F. 120.
Syracuse Storage Battery Co., Syracuse, N. Y., B. 34.
Thomson Meter Co., Brooklyn, N. Y., G. 160.
Tucker Electrical Construction Co., New York, G. 159.
United States Mineral Wool Co., New York, G. 158.
Van Nostrand, D. & Co., G. 162.
Vetter, J. C., & Co., New York, J. 81.
Wagner Electrical Manufacturing Co., St. Louis, Mo., J. 92-93.
Walker Company, Cleveland, O., B. 19-20.
Warren, A. K., & Co., New York, B. 24.
Weston Electrical Instrument Co., Newark, N. J., J. 89.
Worthington, Henry R., New York, B. 36-37.
Western Telegraph Construction Co., Chicago, L. 186-187.
Washburn & Moen Mfg. Co., Worcester, Mass., A. 14-15-16.

EARLY DYNAMOS AT THE EXPOSITION.

Cornell University is among the many contributors of interesting objects at the electrical exposition. It is in possession of the Gramme dynamo, built by Prof. W. A. Anthony as early as 1876, and exhibited as a great curiosity at the Centennial Exposition of that year. It was probably the first dynamo of practical form constructed on those lines in this country. It was used for arc lighting and for a great variety of purposes in those early days. It has remained in use ever since, and Dr. E. L. Nichols writes that even now they are using it at the university. The art has seen many remarkable evolutions, making this machine as great a curiosity in 1896 as in 1876, and it will be doubtless a center of attraction to all students of dynamo construction. Cornell is also exhibiting other things of interest, and its work for the success of the exposition is but natural in an institution that benefited so nobly from the first fruits of electrical invention and industry. It may be added that other very early dynamos are to be shown.

WHAT EXHIBITORS WILL DO.

As the time approaches for the National Electrical Exposition the plans for various exhibits approach maturity, and we are able this week to supplement with many items of interest the news already given.

The Nowotny Electric Company of Cincinnati inform us that they will exhibit their familiar ironclad dynamos and motors and a number of entirely new electric light specialties of their own manufacture.

Mr. R. B. Corey, of New York City, reports that his exhibit will consist of arc lamps for direct and alternating current, knife switches and Sun-Schmelzer-Nürnberg carbons for direct and alternating arcs.

The Standard Underground Cable Company will exhibit some reels of their cable, showing standard fiber insulated cables; standard paper insulated cables, and standard rubber cables. A specialty will be made of samples, representing some of their latest contracts. A rack for show purposes will also be included, carrying samples of their products for distribution. Messrs. G. L. Wiley, with an assistant; Vice-President Marsh, and J. R. Wiley, of Chicago, will be in attendance.

The Siemens & Halske Electric Company will install in connection with the Ball & Wood Company an operating 100-kilowatt direct-connected type "I" external armature dynamo, which is one of eight furnished for the Siegel-Cooper "Big Store." They will also exhibit some of their direct current arc lamps, which, although in wide use abroad, have not yet been pushed much in this country.

The Adams-Bagnall Electric Company, of Cleveland, will have in their exhibit arc lamps for every kind of circuit and in various styles of finish, including "black Japan," "oxidized copper," "oxidized brass," "oxidized silver," "yellow brass," "Japanese copper," nickel and aluminum. It will be one of the finest displays of arc lamps ever made. There will also be shown a quantity of the already well-known "A-B" incandescent lamps.

H. B. Coho & Co., of New York City, report that they will show a 40-kilowatt Eddy multipolar generator directly connected to an Ideal engine; also several 30-kilowatt machines in connection with other engines. In connection with Mr. Augustus Noll they will also exhibit a very fine switchboard. They are also expecting to show a number of small specialties, including electric heating and cooking apparatus, fiber graphite brushes, etc., and will distribute literature, price lists, etc., quite freely.

The General Electric Company are gradually working out their plans for a fine exhibit, part of which has already been referred to in these columns. In the main exhibition hall they will have, somewhat after the style of their Chicago World's Fair display, a handsome headquarters and general reception room, occupying about 400 square feet of space. As a "still" exhibit they will show a few of their latest long-burning arc lamps, a selection of their inclined-coil instruments, and a few meters. A special feature will be made of a fine collection of bromide prints to illustrate the latest types of apparatus they have developed and some of their latest representative installations. So much importance does the company attach to the meeting and exposition that it has appointed a convention committee, as follows: S. D. Greene, chairman; C. T. Hughes, vice-chairman; F. M. Kimball, secretary, A. D. Page, lamp works; T. Beran, New York Supply Department, and F. N. Boyer, of the Chicago Supply Department. The company will also be represented by Messrs. H. J. Buddy, representing the Philadelphia office; A. F. Giles, Atlanta; W. J. Ferris, Chicago, and C. B. Davis, A. R. Bush, C. S. Haley and A. W. Ives, representing the Boston office, together with representatives from the railway, power and mining departments and the New York office.

The Electrozone Company, Mr. A. E. Woolf, its expert and inventor in charge, will have one of the most novel and striking exhibits in the whole building. Mr. Woolf, as is well known, electrolyses salt water and uses the resultant liquid as a disinfector and purifier. He will probably show a little model of Riker's Island, with real garbage, which he will disinfect in sight by playing electrozone on it. He will also illustrate his sewage treatment method, the killing of harmless germs to prove what can be done in germicide, and will also give an elaborate microscopical display. In addition to this he will have a working model of his bleaching process, with which he will treat wood pulp. He will also exhibit his alkali process, decomposing a saline solution, chlorine on one side and alkali on the other. Those who know Mr. Woolf's fertility of resource will not be surprised to find his space one of the nightly centers of attraction.

The Metropolitan Telephone Company's Exhibit, realizing the impracticability of adequately exhibiting the working of its complicated and extensive plant in any

reasonable space, will make an exhibit illustrative of its New York City service as viewed from the user's standpoint. The manner in which this will be carried out involves nevertheless a more elaborate installation than might appear from the exhibit proper, as the company will place telephone stations at a number of exhibitors' spaces, as well as at points where service is desired by the Exhibition company. These stations will be connected to a switchboard in the company's space, thus forming a small exchange within the exhibition itself. This service will be furnished without charge to the exhibitors and to the Exhibition Company by the Metropolitan Telephone Company, which will furnish the entire installation and maintain the service at its own expense. Besides the switchboard the company will install in its own space four silence booths of different types, each equipped with telephone instruments of the various styles used by New York City subscribers. These will all be working stations connected with the Thirty-eighth Street Exchange, and will be available to visitors to the exhibition in the same way as an ordinary public pay station. This remarkably useful form of exhibit will no doubt be highly appreciated by exhibitors, who cannot fail to realize the convenience of being placed in easy communication with each other and with their home offices. The exhibit proper will afford the public ample illustration of the excellent service furnished by the Metropolitan Company and of the high grade of equipment provided for public and subscribers' stations. Those visitors who display particular interest in the operation of a city telephone system will be invited to visit one of the company's large exchanges where they can examine in detail the nature and operation of the plant, which are practically impossible of reproduction in an ordinary exhibition.

The Payne Engine Company, of 41 Dey street, New York City, and Elmira, N. Y., will have one of their new type direct connected engines of 50 horse-power capacity connected to 25-kilowatt Card generator. This machine will undoubtedly be of unusual interest, from the fact that it will have an improved inertia governor of an exceedingly simple form of construction, and one for which are claimed very superior results. The governor consists of but two pieces and one bearing, thus reducing friction to the minimum and the chances of disarrangement. It is stated by the manufacturers that this governor will move through the entire range, viz.: from 0 to 5/8 cut-off, in less than 1-5 of a second; and it overcomes what is commonly known as dancing in the centrifugal governor. The Payne people will have another feature which will attract a good deal of attention. It is an automatic return oil circulation system, by means of which the oil is delivered in a stream to the main bearings by gravity and drained to a central point at the bottom of the base. By means of a small oil pump working on the rocker arm of the valve rod, it is pumped to a receptacle on top of the frame, where it is filtered and re-used. Carefully designed oil guards prevent any oil being thrown from the engines, and at the same time it is not the inclosed type. The Payne Company will be represented at the exposition by S. H. Payne, N. B. Payne and F. N. Jewett, of the New York office.

The Ironclad Rheostat Company, of Westfield, N. J., will have an interesting exhibit to consist of goods that they manufacture, some of which will be in operation. The display will consist of theater dimmers, rheostats for storage batteries, motor starters, speed controllers, standard and special resistances, etc. The company will be represented by Mr. Charl D. Doubleday and Mr. G. L. Colgate.

The Card Electric Motor and Dynamo Company, of Cincinnati, will have a large and striking exhibit in the hands of Mr. R. T. Lozier, their general Eastern agent. It will comprise a 25-kilowatt generator directly connected to a Payne engine. Current will thus be furnished to a Card motor operating a Hoe press, the armature of the motor being directly connected to the shaft of the press in the place of the pulleys. Another Card motor will be shown directly connected to a 37-inch Niles boring mill. A third motor will be directly connected to a Niles 6-inch radial drill, and a three horse-power motor will be belted to a horizontal boring mill. This well-selected exhibit will be supplemented by some special features that are now being worked up.

Mr. A. O. Schoonmaker, New York City, will exhibit sheet mica, showing it in the uncut form, cut to sizes, stamped in segments, washers and in various forms. The exhibit is intended directly for the guidance and information of the trade.

The Interior Conduit and Insulation Co., of this city, have taken considerable space, and will show in operation a printing press run by direct connected Lundell motor; exhaust fan outfits, 60, 36 and 12-inch; direct connected generating set; Lundell power motors, Lundell generators. Lundell desk fans and ceiling fans, Lundell dental outfits, Lundell emery wheel grinder, Lundell buffing machine and Lundell organ-blowing outfit. The latter will be attached to a Mason & Hamlin organ, which will be played each evening. The company will also exhibit their complete system of plain, brass-armored and iron-armored insulating conduits, as well as their complete underground conduit system. The space will be ornamented by an illuminated electric sign, 30 feet in length. The following gentlemen will be specially in attendance to explain the various novelties: D. C. Durland, G. H. Kimber and E. B. Kittle.

The Columbia Rubber Works will have a display, limited strictly to hard rubber specialties and electrical hard rubber appliances, such as push buttons, telephone receivers, hard rubber sheet and tubing, and all goods which go in that class.

The Harrisburg Foundry and Machine Works will have a combination exhibit of one Ideal engine, direct connected to a 40-kilowatt Eddy generator. W. R. Fleming & Co. will have commercial charge of the exhibit in association with H. B. Coho & Co.

ARRANGEMENTS AT THE MURRAY HILL HOTEL.

In designating the Murray Hill Hotel as its official headquarters for its nineteenth convention, the National Electric Light Association has acted wisely. The hotel is not only one of the finest and most beautiful in New York, as well as one of the best conducted, but it is distant only a couple of blocks from the meeting room and the exposition building.

The management of the hotel, having in view the comfort of its guests, has determined to reserve all possible space for their proper entertainment. It has stipulated, therefore, with the association that none of the guests make use of any part of the hotel for exposition purposes, or display any signs or placards in the halls or corridors. This will restrict the exhibition and trade features to the place where they belong, and will leave the hotel as the undisturbed center of the social events of this memorable occasion.

N. E. L. A. TRANSPORTATION.

C. O. Baker, Jr., Master of Transportation, writes that arrangements have been made whereby delegates on the line of the Chicago and Alton road can use that road to Chicago and connect with the electrical special at that point for a fare and one-third, on the certificate plan. This will enable the St. Louis delegates to leave that city at 11:30 p. m. and reach Chicago at 8:30 a. m. the following day, which will enable them to remain in the latter city until the time the electrical special leaves, namely, 5 p. m., Saturday, May 2.

POSTAL WIRES FOR THE OPENING CEREMONIES.

In connection with the opening ceremonies of the National Electrical Exposition, when it is proposed to start the machinery by a circuit that has first looped in the whole continent, the Postal Telegraph Cable Co., through its Vice-President, Mr. W. H. Baker, has very courteously offered its fine service between New York and San Francisco for the purpose. The Postal Company has been equipping its lines with heavy copper circuits, and believes that it can illustrate rapidity of working by the instantaneity of its transmission on May 4, when the mere pressure of the golden key will flash the signal to the Golden Gate and back to the exposition building, in the twinkling of an eye. Arrangements are now being made with the Postal officials for the execution of this interesting plan, with the co-operation of the long string of offices scattered over the 6,000 miles of wire.

STORING NIAGARA ENERGY FOR THE EXPOSITION.

The announcement was made last week of the generous offer of the Western Union Telegraph Company of two wires from Niagara, with which to bring current from the power plant there to run the model of the plant at the exposition. These wires will be available in the evening, and the question thus arose as to what should be done in the way of running the model the rest of the time during each day. Mr. A. S. Brown, the electrical engineer of the Western Union Telegraph Company, suggested that it would be a comparatively easy thing to ship a few storage batteries up to Niagara, charge them there and bring them down for the purpose. This simple but shrewd suggestion has been acted upon, and the Electric Storage Battery Co. of Philadelphia, through Mr. Charles Blizard, its representative in this city, has placed at the disposal of the exposition all the batteries that may be needed, with the permission that this stored Niagara energy can also be turned loose on any other exhibit at will.

There will thus be exhibited the energy of Niagara in a "live" form, coming over the wires in the shape of an alternat-

ing phase current to drive the model by a phase motor; and the stored Niagara energy, which will, of course, be applied to a direct current motor, which will also run the model part of the time. A more interesting illustration of the flexibility of electrical power transmission than this could hardly be desired, as it practically embraces the whole field of modern methods and appliances.

THE EVOLUTION OF THE STOCK TICKER.

An exhibit that is sure to arrest the attention of the numerous visitors to the exposition will be that which shows a stock ticker system in full working operation. To watch the tape unroll with the curt little signs on it is one thing, but to see how the information that means so much to the financial world is gathered and put on the circuits is another matter of interest to everybody. The development of the modern stock-ticker system, so strikingly American, is the result of much ingenuity and enterprise, and has brought many brilliant electricians to the front.

With the object of assisting to a better understanding of the subject, the executive of the Gold and Stock Telegraph Company has generously authorized its superintendent and electrician, Mr. George B. Scott, to place at the disposal of the exposition management a number of old instruments that will be useful in showing how the system as it exists to-day has been worked out to its present stage of efficiency and celerity. Mr. Edison and others are also contributing apparatus of this nature, rendering the display one of unusual value, as such electrical machinery has never been brought together before in this instructive manner.

A LARGE PATENT OFFICE EXHIBIT.

In view of the importance of the occasion, the exhibit of the United States Patent Office at the National Electrical Exposition will be made one of unusual size and interest. As now arranged by the Department, under the instruction of Mr. S. T. Fisher, the acting commissioner, it will include no fewer than 361 separate models of electrical devices, apparatus, machinery and appliances, many of them embodying the fundamental and elementary ideas upon which the modern electrical arts have been founded. These models will occupy over 300 lineal feet, and will be carefully grouped and classified, so that students, of whatever character, can follow the general lines of growth or evolution.

PROFESSOR ELIHU THOMSON AT THE EXPOSITION.

In spite of many pressing engagements, Prof. Elihu Thomson is kindly preparing for the National Electrical Exposition a very interesting personal exhibit. He hopes to ship it to New York from New England in a few days. He has been requested by the management to include in it some of the working apparatus illustrative, in many beautiful ways, of the "repulsion phenomena," his classic investigation of which some years ago is well remembered by all electricians. An endeavor will also be made to secure a lecture from him during the exposition, as it is understood that he will be in New York at that time, and is one of the most successful lecturers of the time in explaining electricity popularly and clearly. A bust of Professor Thomson is now being made by the Riccinilli Bros., of New York, under the direction of the sculptor, Mr. Robert Kraus, of Boston. It is expected to be finished by the end of the month, and the original has consented to its inclusion in the collection of busts and pictures that will adorn the space of the Loan and Historical Exhibit Committee.

ADDITIONAL EXHIBITORS.

During the past week the already long list of exhibitors at the National Electrical Exposition has received several additions, some of them quite large and important. Among these may be mentioned the Joseph Dixon Crucible Company, the Sprague Electric Elevator Company, the Westinghouse Electric and Manufacturing Company and the United Electric Light and Power Company, of this city. The three concerns last named are understood to have taken for their various exhibits about 1,000 square feet. The pressure for space has indeed become embarrassing.

CONTRACTS FOR THE EXPOSITION.

The National Electrical Exposition Company has awarded the following contracts, which are now being carried out: William Andrews, steam piping and fittings; Garrett Wright, boiler and engine foundations; J. E. Phelps, exclusive catalogue privilege.

SOCIETY AND CLUB NOTES.

PROF. THOMSON BEFORE THE ELECTRIC POTENTIALS.

At the annual meeting of the Boston "Electric Potentials," and after the dinner at the Hotel Thorndike, on April 22, Prof. Elihu Thomson will entertain the society by a copiously illustrated lecture on the Röntgen X-ray. Ladies will also be present.

X-RAYS BEFORE THE QUIDNUNC CLUB.

The Quidnunc Club is an uptown organization based on the lines laid down by the Nineteenth Century Club, for the discussion of live topics of the hour. At its April meeting last week, before a large and fashionable audience, Mr. Max Österberg, of Columbia College, gave an admirable popular lecture on the Röntgen ray, with experiments, in which he was assited by Mr. Lovejoy, using an array of Geissler and Crookes tubes, and showing a number of shadow pictures on the lantern screen. After the lecture everybody in the audience was given an opportunity to study anatomy, and the excellent Edison and Le Roy fluoroscopes provided were in great demand, particularly by the ladies, who wished to see how their hands looked when seen through gloves, books, blocks of wood, etc. The lecture was a brilliant success in every respect. One of the auditors, Mr. R. W. C. Merington, mentioned the interesting fact that the last electrical lecture he had heard previous to this was one by Faraday, a personal friend of his, in England, in 1854.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Mr. D. McF. Moore will deliver his lecture on vacuum-tube lighting at the headquarters, 12 West Thirty-first street, on April 22, at 8 p. m. The room will be lit by tubes. Mr. Moore will also illustrate his lecture by lantern slides. Members and their friends will find the occasion one of much interest and importance.

NEW YORK ELECTRICAL SOCIETY.

The Sprague Electric Elevator Company has courteously invited the society to visit its new works at Watsessing Junction, N. J., on the evening of Friday, April 24, for the purpose of seeing how modern high speed electric elevators are constructed and operated. In addition to the opportunities thus presented for studying the subject in all its details, Mr. Sprague has kindly consented to give a brief address on some of the more interesting features and problems of electric elevator work, especially in relation to extremely tall buildings. The most convenient train for reaching the works will be that leaving foot of Barclay street, and foot of Christopher street at 7:50 p. m., D., L. & W. Railroad. Return trains will leave Watsessing every forty minutes up to 12 o'clock. A collation will be provided.

LEGAL NOTES.

A STANDARD UNDERGROUND CABLE CO. SUIT.

Mr. R. B. Waring, formerly connected with the Standard Underground Cable Company, and the original owner of many of its valuable patents, has recently entered suit against Mr. George Westinghouse, Jr., to recover the value of 10,000 shares of stock in said company. The well-known names of the litigants and the large amount involved make the case one of considerable interest.

Mr. Waring claims that the stock in question was transferred by himself to Mr. Westinghouse at the time that Mr. Westinghouse became connected with the company in March 1886; and that the stock was to have been held in trust and for his benefit.

The defense of Mr. Westinghouse to this suit was substantially that the stock in question had been given him outright, to secure his active interest and influence in favor of the company, which was then a new undertaking, and that there was no agreement or understanding that he held the stock for Mr. Waring, and that nothing is due to Mr. Waring on account thereof.

The case was brought to a sudden termination on the 9th inst., when the plaintiff withdrew his suit. The testimony on the main issue, viz., whether Mr. Westinghouse should account to Mr. Waring for the stock in question, appears to have been largely in favor of Mr. Westinghouse up to the time the suit was withdrawn.

MISCELLANEOUS.

MONOCYCLIC DISTRIBUTION AT MIDDLETOWN, OHIO.

ONE of the most interesting modern stations in this country, and the first perhaps which has a larger motor load than a lighting load, is that at Middletown, Ohio, operated by the Middletown Electric Light and Power Company.

It is now some four months since Mr. E. H. McKnight, president and general manager, determined on an increase in his station, which up to that time had operated on a small scale only. The conditions with which he was confronted showed

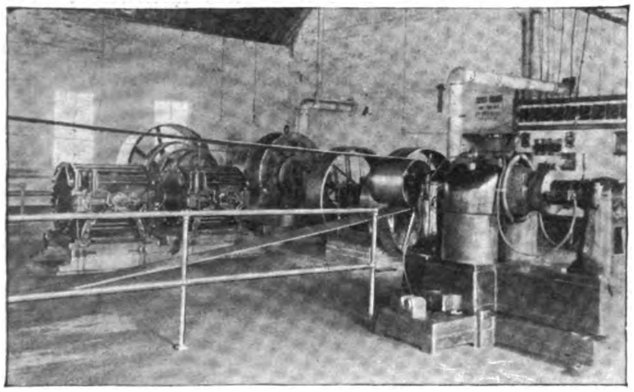


FIG. 1.—THE GENERATING STATION, MIDDLETOWN, OHIO.

the necessity of a system of distribution which would allow him to cope with a large demand for current for motor service during the day and a similarly large one for lighting after dark. As best satisfying these conditions, Mr. McKnight selected the monocyclic system of the General Electric Company.

The power-house is large and well ventilated and is situated near the center of the city in an ideal location for an electric station. It fronts on the Cleveland and Cincinnati Canal, while immediately behind it are the tracks of the M. & C. R. R. Water for the station is taken from the canal in front, and the necessary coal is shoveled directly into the bins from the cars standing on the tracks behind.

The steam equipment consists of two Brownell & Dayton boilers, furnishing steam to one 250 horse-power Russell engine and one 100 horse-power Ball engine. The first runs at

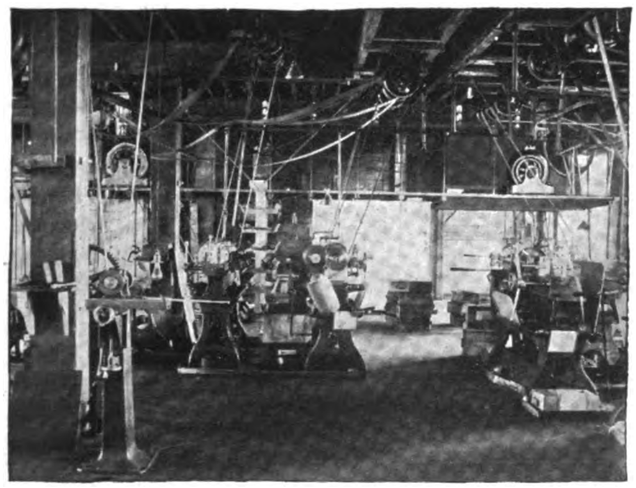


FIG. 2.—CORNER OF MACHINE ROOM, SHOWING INDUCTION MOTORS, IN MIAMI CYCLE FACTORY.

164 revolutions, and drives from a countershaft the new monocyclic generator and two T.-H. 75-light arc dynamos; the latter runs at 285 revolutions and drives a D-62, T.-H. bipolar direct-current low voltage machine. The monocyclic generator is a standard 12-pole machine, running at 600 revolutions. It is rated at 150 kilowatts at 1,040 volts, and is excited by a 1½ kilowatt exciter. The D-62 furnishes current for direct-current motors scattered throughout the city. The arc machines operate lights in the streets, while the monocyclic is wired for about 180 horse-power in motors and 2,000 lights. If all the lights and motors were operated at the same time the total amount of energy required from this generator would be about double its capacity, and its power to cope with the conditions illustrates forcibly the advantages of the monocyclic system. During the day the lights burning are comparatively few, while the motor load is at its maximum. This condition is reversed after dark, when tthe motor load drops off and the lighting load rises in turn. The generator, which runs 23 hours per day, is worked continuously at its highest efficiency and satisfactorily fulfills its double duty without sparking or noticeable heating.

The most important client of the Middletown station is the Miami Cycle and Manufacturing Company, whose factory is located about one mile distant. It takes current for 180 horse-power in motors; for 800 incandescent lamps, of which 400 are usually in use, and for six arc lamps. The Cycle Company turns out about 200 wheels a day and employs from 500 to 600 hands.

The current is transmitted from the station to the works over two mains and a teaser wire at about 1,000 volts and is reduced to about 115 volts in six 30,000 watt oil cooled transformers installed in a small house erected in the angle of the L-shaped main building. All the motors derive their supply of current from these transformers connected in multiple. The lighting circuits are taken off from two 7,500 and one 15,000-watt transformers. The primary wires from the station are passed through a station wattmeter just before they arrive at the transformers, and thus the consumption of energy in both lighting and motor circuits is measured in one instrument.

The secondaries run from the small sub-station north and

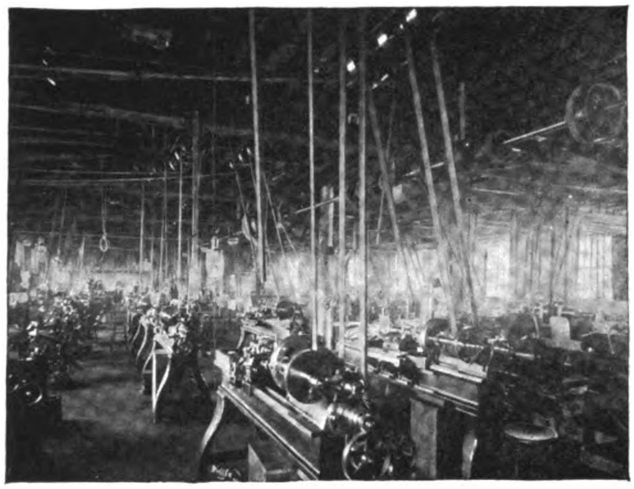


FIG. 3.—MACHINE ROOM, DRIVEN BY INDUCTION MOTORS, MIAMI CYCLE FACTORY.

south to the motors and lights in the two legs of the L. Those running south operate in the machine shop three 20 horse-power motors, each belted to a long line of shafting, from which run 80 belts.

The feeders running north supply energy to three 30 horse-power motors, two of 10 horse-power and two of 5 horse-power supplying power to the drill room, the pattern room and the frame-making department.

A large portion of the power which comes into the factory is used in the polishing room, where 35 double polishing lathes run incessantly. These are operated at present by two 30 horse-power motors. The remaining 30 horse-power motor in the north section drives a 48 inch exhaust blower, which carries away the dust from the polishing room. Located in the assembling department is a 5 horse-power motor, which operates a freight elevator of 1,500 pounds at 60 feet per minute capacity, which runs up and down through the room.

All these motors are of the General Electric induction type, without commutator, collector or moving contacts. They are set up on platforms swung from rafters in the rooms, an arrangement rendered possible by the fact that they require no attention beyond an occasional oiling, and thus occupy no floor space.

In addition to the load at the Miami Cycle Works, the monocyclic generator supplies current to 500 to 600 lights throughout the town, and 650 incandescents in the Sorg Opera House.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS ISSUED APRIL 14, 1896.

Alarms and Signals:—

SIGNALING SYSTEM FOR ELECTRIC RAILWAYS. F. Bathurst, Schenectady, N. Y., 558,028. Filed July 15, 1893.
Signal and block lights located at either end of a section of track, with a two-way switch connecting the block lights with ground in one position and with the trolley in the other.

Primary Batteries:—

BATTERY. W. Morison, Montclair, N. J., 558,091. Filed May 8, 1894.
An invertible single fluid battery.

Conductors, Conduits and Insulators:—

ELECTRIC WIRE CLEAT. F. B. Evans, Clinton, Mass., 558,165. Filed Aug. 26, 1895.
Comprises two separate and similar parts having interlocking faces.

Distribution:—

TRANSFORMER AND METHOD OF COOLING SAME. W. S. Moody, Lynn, Mass., 558,090. Filed Jan. 17, 1896.
Employs coils of wire surrounded by an iron core, and an insulating medium flowing down the outside of the core in the film.

Dynamos and Motors:—

ARMATURE WINDING. A. F. Batchelder, Schenectady, N. Y., 558,027. Filed Jan. 25, 1896.
An armature winding made in the form of a cloth, in which the conductors form one element and suitable insulating material the other.

COMMUTATOR. D. P. Thomson and A. R. Goranson, Schenectady, N. Y., 558,120. Filed Dec. 19, 1895.
An automatic ventilating commutator constructed with radial fan, air passages, deflectors and an annular chamber having outlets for the air at a point above the interior of the commutator.

CARBON BRUSH HOLDER FOR ELECTRIC MACHINES. W. E. Knowlton, Portland, Me., 558,184. Filed Feb. 19, 1896.
Details of construction.

ALTERNATING CURRENT MOTOR. H. L. Tyler, Corning, N. Y., 558,239. Filed July 10, 1894.
A synchronous motor with commutator for the field current.

Electro-Metallurgy:—

APPARATUS FOR ELECTROLYTIC PRODUCTION OF ZINC. R. Encke and O. Frölich, Berlin, Germany, 558,052. Filed July 31, 1895.
Partition plates extend lengthwise in the cell and means are provided to freely circulate the electrolyte.

Lamps and Appurtenances:—

COMPOUND MOLD FOR FORMING INCANDESCENT LAMP BASES. J. Hanny and A. Pederquist, Schenectady, N. Y., 558,070. Filed Nov. 29, 1895.
Details of construction.

INCANDESCENT LAMP. K. O. E. Trobach, Pankow, Germany, 558,122. Filed April 18, 1894.
An electric lamp comprising a bell-shaped incandescing body of flexible and spongy carbon.

Miscellaneous:—

METHOD OF AGING PERMANENT MAGNETS. E. P. Cox, Lynn, Mass., 558,045. Filed Feb. 21, 1896.
Consists in revolving an electrical conductor in the field of a permanent magnet, thereby cutting the lines of force, reducing the flux, and causing the remaining flux to be permanent.

ELECTRIC TRAP RELEASE. J. A. R. Elliott, Kansas City, Mo., 558,051. Filed July 11, 1895.
Employs electromagnets.

ELECTRICALLY ACTUATED DENTAL PLUGGER. A. W. Browne, Prince's Bay, N. Y., 558,153. Filed Nov. 6, 1895.
Details of construction.

PROCESS FOR ELECTRIZING WATER FOR HEATING PURPOSES. P. Huber, Saginaw, Mich., 558,176. Filed April 1, 1895.
Comprises the manufacture of oxygen and hydrogen gases by the electrization of water and storing and using these gases for heating.

METHOD OF UTILIZING SALINE SOLUTIONS. C. N. Waite, Rumford, Me., 558,240. Filed March 19, 1894.
Employed in the treatment of wood fiber, for bleaching.

METHOD OF UTILIZING SALINE SOLUTIONS. C. N. Waite, Rumford Falls, Me., 558,241. Filed Oct. 8, 1895.
Relates to above.

ELECTRICALLY OPERATED MEANS FOR CONTROLLING VALVES. C. M. Bush, Bristol, Conn., 558,256. Filed Jan. 24, 1895.
A double magnet with reciprocating armatures connected to a valve-controlling device.

ELECTRICAL FURNACE. M. R. Conley, Brooklyn, N. Y., 558,357. Filed Sept. 25, 1895.
Comprises a vessel of a composition containing carbon, integral arms on opposite parts of the vessel of the same material, and terminals of an electric circuit connected to said arms.

ELECTRIC MINE CAGE AND ELEVATOR. C. J. Cutler, Butte, Mont., 558,450. Filed June 26, 1895.
Details of construction.

TEMPERATURE REGULATOR. H. Gillette, Highland, Park, Ill., 558,453. Filed July 19, 1895.
The valves have three positions instead of two.

ELECTRICAL HAIR CUTTER AND SINGER. F. M. Bell, New York, 558,465. Filed March 22, 1895.
A comb, wire or bar stretched along the comb, the electrical connections and means for closing and breaking the circuit.

Railways and Appliances:—

ELECTRIC RAILWAY SYSTEM. H. M. Brickerhoff, Chicago, Ill., 558,033. Filed June 13, 1895.
Provides an arrangement of the meeting ends of the sections.

ELECTRIC RAILWAY. L. W. Reid, Mound, Tex., 558,110. Filed Aug. 8, 1895.
Conductor is placed at top of conduit. Contact is made by trolley and a guide wheel is employed to maintain contact.

ELECTRIC RAILWAY SYSTEM. W. M. Brown, Johnstown, Pa., 558,151. Filed Nov. 29, 1895.
A contact box for electric railways, having a plurality of magnetic conductors substantially insulated magnetically from each other and having a recess or cavity between them into which the contact member is adapted to enter.

ELECTRIC RAILWAY. H. L. Tyler, Corning, N. Y., 558,238. Filed July 11, 1894.
Comprises a working circuit composed of track rails, a plurality of transformers connected in multiple arc with said working circuit, and a primary inducing current charged with alternating currents of high potential and composed of an independent insulating outgoing conductor, and a return leg formed by one side of the track or working circuit.

UNDERGROUND SYSTEM FOR ELECTRIC RAILWAYS. A. S. Krotz, Springfield and W. P. Allen, Chicago, Ill., 558,283. Filed Aug. 23, 1895.
A series of sectional tubes inclosing a conductor, contacting devices supported on said tubes and a connection from said conductor to each of said contacting devices.

CONDUIT OR SUBWAY FOR ELECTRIC RAILWAYS. A. S. Krotz, Springfield, O., and W. P. Allen, Chicago, Ill., 558,284. Filed Dec. 2, 1895.
Provides sectional contacting rails doubly insulated from the conduit.

ELECTRIC RAILWAY. D. N. Osyor, Newark, O., 558,303. Filed Jan. 23, 1889.
Especially designed for mine work.

ELECTRIC RAILWAY. C. F. P. Stendebach, Leipsic, Germany, 558,322. Filed March 7, 1895.
Contact is made between the underground conductor and the contact rail by a depression of the latter.

TROLLEY ATTACHMENT FOR ELECTRIC CARS. R. Skeen, Madison, Ill., 558,429. Filed Sept. 9, 1895.
A mechanism placed in an electric circuit with the trolley and adapted to check the upward movement of the trolley when the latter is disengaged from the trolley wire.

Regulation:—

SAFETY DEVICE FOR ALTERNATING SYSTEMS. E. J. Berg, Schenectady, N. Y., 558,031. Filed Oct. 5, 1895.
Means for supplying an interposed electromotive force of displaced phase to the motor, such means being brought into operation by an interruption of the supply in either of the circuits.

REGULATING INDUCTION MOTOR. W. B. Potter, Schenectady, N. Y., 558,104. Filed Jan. 15, 1896.
The fields are permanently connected in multiples and the circuits of their armatures closed through resistances.

REGULATING ALTERNATING CURRENT MOTORS. C. P. Steinmetz and E. J. Berg, Schenectady, N. Y., 558,119. Filed Dec. 28, 1895.
In combination, lines between which single-phase electromotive force is maintained, transformers having their primaries connected in series between such lines and having a secondary in reversed relation to the remaining secondaries of the transformers, lines leading from the secondaries, and a multiphase motor connected to such lines.

Switches, Cut-Outs, etc.

AUTOMATIC CUT-OUT AND RESISTANCE REGULATOR. E. B. W. Reichel, Gross-Lichterfelde, Germany, 558,109. Filed Dec. 27, 1895.
A stationary contact against which normally rests a movable contact.

RHEOSTAT PLATE. J. P. Ball, Philadelphia, Pa., 558,252. Filed Jan. 27. 1896.
A resistance plate having grooves and a wire bent upon itself to form a convolute and held in place within the groove.

PUSH BUTTON SWITCH. H. E. Nickerson, Cambridge, Mass., 558,299. Filed Dec. 7, 1895.
Details of construction.

ELECTRIC SWITCH. C. G. Bergquist, Chicago, Ill., 558,343. Filed June 25, 1895.
Adapted for attachment to electric fixtures and resembling a gas key in appearance.

ELECTRIC RHEOSTAT. F. H. Doane, Newton, Mass., 558,362. Filed Sept. 30, 1895.
The resistances are composed of one or more bars of highly resisting material.

Telegraphs:—

AUTOMATIC TELEGRAPH REPEATER. A. E. Collyer, Monmouth, Ill., 558,042. Filed Dec. 26, 1893.
Employs electromagnets to operate a pivotally mounted bar to open and close a circuit.

Telephones:—

CONNECTION FOR TELEPHONE APPARATUS. P. Rabbidge, Sydney, New South Wales, 558,106. Filed May 20, 1895.
The transmitter, receiver and battery remain constantly in the line circuit.

TELEPHONE SERVICE REGISTER. S. D. Field, Stockbridge, Mass., 558,167. Filed Aug. 21, 1895.
Employs a lever or device whose position is changed during the use of the telephone transmitter or receiver.

CALL COUNTER FOR TELEPHONES. S. D. Field, Stockbridge, Mass., 558,168. Filed Aug. 21, 1895.
Relates to above.

APPARATUS FOR COMPOSITE TRANSMISSION OF INTELLIGENCE. F. A. Pickernell, Newark, N. J., 558,310. Filed Oct. 17, 1894.
Provides means whereby the telegraphic induced currents are prevented from causing the telephonic signal receivers from giving false signals in the normal circuit.

TELEPHONE TRANSMITTER. A. W. Rose, New York, 558,313. Filed Aug. 29, 1895.
A diaphragm, electrodes, having a vibratory relation with each other, comminuted carbon mounted between said electrodes, and sloping flexible walls arranged at an angle to the direction of said vibration.

TELEPHONE TRANSMITTER. W. R. Cole, Detroit, Mich., 558,354. Filed May 15, 1894.
Employs a suspended oscillatory electromagnet in the circuit of the transmitter and carrying the outer electrode.

TELEPHONE BELL. R. D. Harrigan, Leadville, Colo., 558,385. Filed Nov. 5, 1895.
Provides means whereby the bell will continue to be sounded after the main circuit shall have been opened.

Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

O. C. WHITE COMPANY ADJUSTABLE INCANDESCENT LAMP-HOLDERS.

The reputation of the adjustable holders for incandescent lamps made by the O. C. White Company, Worcester, Mass., is now well established. The special claims made for these holders are: Their great range of movement, their smoothness and ease of action, their adjustability and ease of placement without attention to fastenings, their retention of lamp and shade at any angle above, below or at any position in relation to the object lighted; their protection of conductors from contact with moving parts of machinery, etc., and their adaptation as overhead pendants, wall brackets and standard supports. These claims have been so well vindicated that the

WHITE'S ADJUSTABLE LAMP HOLDER.

judges at the Columbian Exposition in Chicago gave to the holders the highest award it was in their power to bestow.

One favorite style, for direct attachment to desk or bench, is that shown in the accompanying engraving; it is especially adapted for easily placing the lamp in all positions through a considerable range while the operator is seated. It is much used by bookkeepers, sewing machine operators, jewelers, etc. Another holder, whose practical utility has been proved by many years' steady demand, consists of an ornamental bracket for desks, offices, libraries, etc. It has unrestricted movement to any position within a range of three feet, and has been found invaluable where the ability to make a quick change of the position of the lamp is essential.

ELECTRICAL SUPPLIES WANTED FOR THE GOVERNMENT PRINTING OFFICE, WASHINGTON.

THE Government Printing Office, through Thomas E. Benedict, public printer, is inviting proposals until May 7 for furnishing a quantity of articles for that department, as follows: 4,000 Columbia incandescent lamps, 16 c.-p., 110 volts, 50 watts, Edison base; 500 Columbia lamps, 25 c.-p., 110 volts, 78 watts, Edison base; 4,000 Perkins lamps, 16 c.-p., 110 volts, 50 watts, Edison base; 500 Perkins lamps, 25 c.-p., 110 volts, 78 watts, Edison base; 4,000 Packard lamps, 16 c.-p., 100 volts, 50 watts, Edison base; 500 Packard lamps, 25 c.-p., 110 volts, 78 watts, Edison base; 500 rosettes, with extra heavy lugs, for cleat work; 500 rosettes, with extra heavy lugs, for moulding work; 3,000 porcelain cleats, 2-wire; 1,000 hard rubber bushings for Edison sockets; 1,000 wooden socket handles, hard wood and polished; 1,000 cord adjusters, 100 attachment plugs to fit Edison sockets; 1,000 key sockets, polished brass, Edison type; 300 keyless sockets, polished brass, Edison type; 100 keyless wall sockets, Edison type; 50 pounds Grimshaw tape, black, ¾-inch wide; 30 pounds pure rubber tape; three gross shade holders, 3¼ inches, Gleason clamp; 1,000 white porcelain deep shades, 10 inches in diameter, for 3¼ inch holder; 4,000 pairs incandescent arc light carbons, ⅝-inch diameter (upper carbon to be cored and the lower solid); 50 gallons "P. & B." paint; 50 cut-outs, No. 61,465 of General Electric Catalogue, No. 7,503; 30 cut-outs, No. 61,487 of General Electric Catalogue, No. 7,503; 12 cut-outs, No. 61,243 of General Electric Catalogue, No. 7,503; 25 cut-outs, No. 62,835 of General Electric Catalogue, No. 7,503; 3,000 yards lamp cord, No. 18 B. & S. gauge, to have a seamless rubber insulation and an outer covering of cotton; 10 pounds Shawmut fuse wire, 1-ampere; 10 pounds Shawmut fuse wire, 10-ampere; 10 pounds Shawmut fuse wire, 20-ampere; 10 pounds Shawmut fuse wire, 50-ampere; 10 pounds Shawmut fuse wire, 75-ampere; 20 pounds Shawmut fuse ribbon, 100-ampere; 20 pounds Shawmut fuse ribbon, 150-ampere; 20 pounds Shawmut fuse ribbon, 200-ampere; 20 pounds Shawmut fuse ribbon, 250-ampere; 200 fuse links, 10-ampere, 1⅝ inches from center to center; 300 fuse links, 20-ampere, 1⅝ inches from center to center, 300 fuse links, 30-ampere, 1⅝ inches from center to center; 200 fuse links, 50-ampere, 1⅝ inches from center to center; 100 fuse links, 100-ampere, 4½ inches from center to center; 100 fuse links, 150-ampere, 4½ inches from center to center; 50 fuse links, 200-ampere, 4½ inches from center to center; 10,000 feet fire and moisture-proof wire, No. 12 B. & S. gauge; 5,000 feet fire and moisture-proof wire, No. 10 B. & S. gauge; 1,000 feet fire and moisture-proof wire, No. 8 B. & S. gauge; 5,000 feet fire and moisture-proof wire, No. 6 B. & S. gauge.

The last four items are to have two braids of underwriters' insulation and an outer covering of moisture-proof insulation to withstand a temperature test of 250° F., without impairment to insulation test. The wire to be delivered on reels containing 1,000 feet each. The reels will not be paid for by the Government, but will be returned to the contractor at his expense. 10,000 feet rubber wire, No. 12 B. & S. gauge; 5,000 feet rubber wire, No. 10, B. & S. gauge; 1,000 feet rubber wire, No. 8 B. & S. gauge; 5,000 feet rubber wire, No. 6 B. & S. gauge.

The last four items are to have a seamless rubber insulation and an outer covering of both tape and braid. Bidders must state guarantee as to action of acid fumes, acid solutions and alkalies upon the insulation; also what guarantee in rise of temperature above the surrounding atmosphere such wire will stand without impairing the insulation test and durability of the covering. Insulation resistance must not be less than 1,200 megohms per mile. Conductivity of copper to be not less than 98 per cent. A certified guarantee of wire for three years must accompany each proposal. The wire to be delivered on reels containing 1,000 feet each. The reels will not be paid for by the Government, but will be returned to the contractor at his expense.

LE ROY'S PORTABLE X-RAY APPARATUS.

The enormous aid which the X-ray apparatus can render to the physician and surgeon is now so well recognized that there can be no question as to the place which this valuable aid will occupy in the equipment of the medical fraternity.

Mr. J. A. Le Roy, of 143 East Thirteenth street, New York, has undertaken to place in the hands of the physician, as well as the scientific amateur, a complete X-ray outfit, consisting of coil, tube and fluoroscope, which is perfect in every respect. The coil is made specially for the tube, so that it can not perforate or destroy it, and the accompanying batteries are also exactly designed for the coil. Either bichromate or storage batteries are employed. The outfit is large enough to cover a shadow picture on an 8 x 10 or 10 x 12 plate .

The fluoroscope made by Mr. Le Roy consists of a tungstate of calcium screen, but, instead of spreading the salt on cardboard, Mr. Le Roy uses a sheet of aluminum of No. 30 gauge. This screen, Mr. Le Roy claims, has four times the fluorescing power of a cardboard screen, and gives a far sharper detail and clearer outline. Mr. Le Roy also makes fluorescing screens of special sizes with or without the fluoroscope attachment.

CROOKES TUBES.

Although the General Electric Company commenced very early in the present year to experiment on the making of Crookes tubes for producing Röntgen rays, it is only after a long series of careful observations that the company has decided that it was ready to put Crookes tubes on the market. As will be seen in our advertising columns, the Edison Decorative and Miniature Lamp Department is now ready to supply Crookes tubes of approved sizes and types. We are informed that very successful results have been obtained with the tubes already furnished by them. Experiments are being continued, in order that tne most improved forms may be within reach of the public constantly.

THE KEYSTONE SOCKET COMPANY has been incorporated at Wilmington, Del., by G. King, E. Shilling, and J. M. Davidson, with a capital stock of $100,000.

WESTERN TELEPHONE CONSTRUCTION CO.

The new Richmond (Va.) Telephone Exchange is the largest plant thus far started in opposition to the Bell Company. The apparatus for this exchange, to the number of 2,000 telephones and switchboard capacity, is being supplied by the Western Telephone Construction Company of Chicago. The new multiple switchboard being furnished to Richmond is the latest improvement in modern telephony. Mr. Keelyn, who designed the system, states that for large exchange work these switchboards will be the most rapid and effective of anything heretofore known. He says that no more movements are required to reach any subscriber in the system than are required with the Western No. 1, for small exchanges, which is claimed to be the most rapid and effective switchboard yet put into practice. The Richmond contract is 25 per cent. larger than any heretofore closed by the independent telephone companies for apparatus.

CALCIUM CARBIDE.

We are informed by "Progressive Age" that the very large extra edition of that journal for April 15, containing the Houston, Kennelly and Kinnicutt reports on carbide of calcium and acetylene gas, was exhausted within forty-eight hours after the appearance of that number. The publishers immediately prepared a second edition of 20,000 copies, which is now ready for those interested in reading the reports of these experts, which can only be found in full in "Progressive Age," the leading gas journal of this city.

NEW YORK NOTES.

THE ELECTRIC ARC LIGHT COMPANY, INCORPORATED, who make the Pioneer inclosed arc lamps, have removed to 687-689 Broadway, where they will have increased facilities for handling their trade.

MAURICE SICHEL has been appointed receiver for Frederick C. Timpson, dealer in electrical supplies, formerly at No. 143 Liberty street, on the application of the Electric Engineering and Supply Company, of Syracuse.

THE H. P. BALL MANUFACTURING COMPANY, of Brooklyn, has been organized to manufacture electrical appliances with a capital stock of $20,000. The directors are John E. Ball, C. B. Keough and M. A. Vosburgh, of Brooklyn.

MR. LOUIS J. HIRT, of the engineering staff of the Metropolitan Traction Company, after some very heavy work the past winter, particularly in putting the Lenox avenue conduit line in good working order, has taken a European trip, leaving by the City of New York on April 15. He will be gone several weeks.

D. VAN NOSTRAND COMPANY, Murray and Warren streets, New York City, have issued a new classified catalogue of electrical books, the chief feature of which is the careful and excellent arrangements by subjects. The list is very comprehensive and correct, and gives evidence of the enterprise of this old concern, whose other lines of scientific literature are not less extensive.

THE PHŒNIX INTERIOR TELEPHONE CO., who for the past year have conducted an extensive business in the manufacture of battery telephones at 131 Liberty street, will on May 1 remove their works to much larger quarters at 108 Greenwich street. In addition to their factory the company will open a large store on the ground floor of the Liberty Building, corner of Liberty and Greenwich streets, where they will carry a full line of electrical supplies.

NEW ENGLAND NOTES.

THE BERLIN IRON BRIDGE COMPANY, of East Berlin, Conn., have the contract to furnish the New Britain Knitting Company the steel work for their new boiler plant. The roofs of the buildings will have steel trusses throughout, and in designing these buildings everything has been so constructed as to render them thoroughly fireproof.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY have issued circular No. 20 (Catalogue, No. 146) devoted to "Current Practice in Protecting Electrical Apparatus Against Lightning." The article is by Mr. A. J. Wurts, and is, of course, an admirable exposition of the subject. It is supplemented by a number of interesting reports from central station managers all over the country.

PHILADELPHIA NOTES.

THE C. C. CLARK COMPANY has been incorporated under the laws of New Jersey, with a capital stock of $50,000 to construct steam and electrical plant. The headquarters will be in Philadelphia.

THE HUNTERDON ELECTRIC COMPANY, of Lambertville, N. J., have recently purchased a 100-h. p. Ball engine from the Parker Engineering Company, Philadelphia representatives of the Ball Engine Company, of Erie, Pa.

MR. CHARLES WIRT, 1028 Filbert street, Philadelphia, has enlarged quarters and increased facilities for the manufacture of the Wirt dynamo brush. Mr. Wirt reports that he has been making radical changes in methods of manufacture, as the old methods were too slow to keep pace with increasing business and too expensive to meet competition. The Wirt brush of to-day is being modified to suit different classes of machines, as it has been proved that the best combination of material for one case, is not the best for every case.

THE CUTTER ELECTRICAL AND MANUFACTURING CO. have just sent us their new catalogue of C-S. flush switches and accessories. It is the handsomest switch catalogue that has yet been printed, the numerous cuts shown being printed in photographic brown, with the letterpress in an attractive shade of green. Full details are shown as to the interior construction of the switch, and plans for wiring are also given. The switches have so long been before the public that an indorsement is unnecessary, but a short list of some of the users is printed on the last page of the catalogue, and these names bear out their claim that the C-S. switches are the standard for high-grade work. The catalogue is very artistically bound in heavy artists' paper, attractively printed in red and black. Ten thousand are now ready for distribution and will be sent upon application.

WESTERN NOTES.

THE HARTLEY ELECTRICAL WORKS, of Chicago, have removed from their old stand at 373 Dearborn street to much more commodious and lightsome premises at 263 Randolph street.

MR. WELLS GOODHUE has recently returned from a trip amongst his numerous customers, and is pleased to become acquainted with the smoke and dust of the Windy City once more.

WEST CHICAGO PARKS.—The specifications for the West Chicago Parks electric light plant will be ready for distribution on Thursday, April 23, and copies can be procured from Mr. Forée Bain, electrical engineer, 1657 The Monadnock. Bids will be opened on Tuesday, May 12, at the office in Union Park.

MR. E. P. ROBERTS has been appointed by Messrs. Yost & Packard, architects, as consulting engineer for the electric light and power and steam heating, and also the hydraulic and sanitary engineering, for the new Ohio State Asylum for the Insane, at Massillon, O., a very large institution, built on the cottage principle.

ELECTRIC APPLIANCE COMPANY.—As summer approaches the fan motor business awakes from a winter's slumber. The Electric Appliance Company already have quite a large stock of Meston alternating current fan motors, and are ready to do business in this specialty. Anticipation of requirements is always a good policy in placing orders for seasonable goods of this kind, and the Electric Appliance Company suggest that orders be placed as early as possible for the season's demands.

MR. JOHN F. OUTWATER, representing Hugo Reisinger, 38 Beaver street, New York, in passing through Chicago on his way home last week, made a pleasant call at the office of The Electrical Engineer. Mr. Outwater made a long and extensive business trip, and is quite pleased with the results. He was fortunate enough to escape the winter snows while on his journey, as he worked from the far Southern States to the Pacific coast, and now strikes his native soil at the brightest of all seasons.

CROOKES TUBES can now be purchased from the Sunbeam Incandescent Lamp Company, Chicago. This company has been experimenting continuously since the first announcement of the results obtained by Professor Röntgen and claims in its "Sunbeam X-ray Tube," as it is called, that the rays are brought together and in consequence a photograph can be produced that shows much sharper outlines. Also with this tube, the time of exposure is reduced. The Sunbeam tubes have been sold to several colleges where they have been pronounced superior to other American tubes.

Department News Items will be found in advertising pages.

SUPPLEMENT TO

THE

Electrical Engineer.

Vol. XXI. APRIL 22, 1896. No. 416.

THE GENERAL ELECTRIC REPORT.

WE give below a very full synopsis of the annual report of the General Electric Company. It shows sales of about $12,730,000 of apparatus. The deficit is somewhat cut down, but the profit and loss still stands nearly $14,000,000, and the patent and franchise account is put at $8,000,000, although any value above one or two millions must certainly seem problematical. The company would appear to be worth about 40 cents on the dollar.

FOURTH ANNUAL REPORT OF THE GENERAL ELECTRIC CO.

BELOW is given the annual report of Mr. C. A. Coffin, president of the General Electric Co., under date of Jan. 31, and issued from Schenectady under date of April 18:

In their last report, your directors referred at some length to the liquidation of old assets, and stated that the sum of $2,000,000 had been charged to profit and loss, for the purpose of providing for all shrinkages which could then be anticipated in the liquidation of old matters.

Much has been accomplished in the year just closed in liquidating old and slow assets, and the condition of the assets of like character which still remain on the books of the company is such as to enable your officers to more definitely fix their proper values. Information regarding these matters will be found in the report of the second vice-president, to which particular attention is invited. There have been charged against the $2,000,000 item above referred to the sum of $530,152.16, representing the shrinkages which have accrued from the liquidation so far as completed, leaving $1,469,847.84 still standing to provide for possible shrinkages in the future. It is the belief of your directors that this amount is sufficient to cover all the purposes for which the above sum of $2,000,000 was originally set apart.

The business secured by your company for the fiscal year just closed was less than ten per cent. greater in value of sales than for the year previous. The actual increase in output of factories, based upon capacity of machines and number of articles produced, is more than thirty per cent. greater than for the previous year. While the selling prices as thus shown have been materially reduced, there has been a corresponding curtailment in manufacturing and other expenses and lowering in costs, largely due to improved designs and methods of manufacture.

As will be seen by the statement of profit and loss, the business of the year just closed including royalties, amounted to..		$13,315,667.12
Cost of goods sold, plus legal, patent, and general expenses and taxes, was		11,759,857.08
		$1,555,810.04
Less interest on debentures in excess of interest and dividends received	$16,459.40	
Sundry losses................	27,178.31	
Depreciation on inventories and consignments........	123,204.87	166,842.58
Leaving		$1,388,967.46
There is charged off, in writing down factory plants, patents, etc., the sum of		511,321.97
Leaving net..............................		$877,645.49

Sales Department.—Attention is called to the report of the first vice-president, covering the operation of this department. From this report it will be seen that more than 90 per cent. of all the sales for the year were on the basis of cash within sixty days from shipment. The organization of this department is most excellent and effective, and the total expenses of selling and distributing the products of your factories during the past year have been materially less than for any previous year.

Manufacturing and Engineering.—By referring to the report of the third vice-president, in charge of manufacturing, much information will be gained as to that important branch of your business. Your directors are fully alive to the necessity of maintaining in this department the highest possible standard of economy and efficiency and they believe that the results so far attained in this direction are of the greatest value and importance. The achievements of your company in notable installations, involving the highest class of engineering and mechanical skill, have been especially gratifying.

Arrangement with the Westinghouse Company.—Since the close of the fiscal year a contract has been concluded with the Westinghouse Electric and Manufacturing Company, which embodies a recognition of the patents of each company by the other and the right, subject to certain exclusions, to a joint use thereof. An official notification of this contract was given out on March 13, and since then details necessary to make the arrangement effective have been concluded. It is believed that many advantages will be derived from this contract, specially in eliminating much costly litigation, and in the important relations of co-operation in engineering and manufacturing methods.

Patent Litigation.—The suits on the Van Depoele electric railway patents have progressed practically to a conclusion. In one case—that against the Elmira and Horseheads Railway Company—the United States Court of Appeals for the Second Circuit has rendered a decision finally sustaining the patent involved in that suit, and giving it a construction which brings within its scope the standard devices universally used for switching electric cars having an overhead trolley. In this suit were also sustained other claims of substantial importance.

In the suit against the Winchester Avenue Railroad Company, the Circuit Court of the United States for the Second Circuit has sustained the main Van Depoele trolley patent, giving it a construction which brings within its scope the standard overhead trolley cars in general use. These decisions are regarded as of great importance, and we believe that the above named patents having now been established by the courts will prove of substantial value to the company.

Suits on other patents in the railway and lighting field are pending, and are being actively pushed; some of these will come to a hearing during the coming year.

A number of valuable patents have been acquired by the company during the past year.

General Conditions.—The prices of your company's products have undergone excessive shrinkages in the adverse conditions of the past three years, and the securities held by it in local companies which were constructed upon the high prices of the past depreciated in like degree during the panic of 1893 and in the year subsequent thereto. Greatly modified valuations of your various assets have thereby been made necessary from time to time, and much information relating thereto has been brought to your attention in former reports.

It is believed that the necessity of further reduction of aggregate values will not arise, nor is it expected that the market prices of your products can suffer any substantial decline in the early future. The local enterprises in which your company is interested as a creditor or security holder are, as a rule, returning to normal conditions. Many of them give promise of greatly increased prosperity.

Similarly the inventories and other investments of your company are in such shape as to lead your directors to anticipate no shrinkage therein, beyond that for which provision has been made. In the mean time the varied applications of electricity are increasing and the output of the company's works should be augmented as a result of the added uses to which electrical apparatus is almost daily being put.

It will be noticed by referring to the Profit and Loss Statement that the revenue derived by your company from interest and dividends for the past year was nearly sufficient to provide for the interest on its outstanding debentures.

Capt. Eugene Griffin, as first vice-president, submits a statement of the operations of the sales department, for the year ending Jan. 31, showing a total of $12,730,058, made to over 10,000 customers, on a total number of 104,000 separate orders, or about 350 a day. Besides the regular supply business, which includes 9,000 separate articles, as well as renewals, the company sold nearly 12,000 complete machines, of a total of 500,000 horse-power. These figures include over 8,800 street railway motors, and 90,000 horse-power of railway generators. They were supplemented by nearly 6,000,000 incandescent lamps and more than 27,000 meters.

Over 93 per cent. of the sales provided for cash within sixty days. Only three-tenths of 1 per cent. provided for payment in stocks, bonds or exchanged apparatus.

Capt. Griffin's report refers in detail to new openings for goods and current, such as heavy railroad work, conduit roads,

CONSOLIDATED PROFIT AND LOSS ACCOUNT OF JANUARY 31, 1896.

EXPENSES.

Cost of Goods Sold	$9,860,216.09	
General, Patent and Legal Expenses and Taxes	1,899,640.99	
		$11,759,857.08
Sundry Losses	27,178.31	
Depreciation on Inventories	101,191.43	
" " Consignments	22,013.44	
		150,388.18
Interest on Debentures		437,500.00
		12,347,740.26
Balance carried down—Profit of the Year		1,388,967.46
		13,736,707.82
Balance January 31, 1895		14,794,716.97
Written off Factory Plants	322,339.43	
" Other Real Estate	29,718.52	
" Patents and Franchises	159,264.02	
		511,321.97
		$15,306,038.94

EARNINGS.

Sales	$12,730,058.07	
Royalties and Sundry Profits	585,609.05	
		$13,315,667.12
Interest and Dividends received on Securities owned	320,256.54	
Interest and Discount	100,784.06	
		421,040.60
		13,736,707.72
Balance brought down		1,388,967.46
Balance January 31, 1896		13,917,071.48
		$15,306,038.94

phase power transmission, rotary converters, mill and mining plants, and the use of electricity in the chemical arts, such as the process of making calcium carbide, electric smelting, making bleach powder, etc.

Mr. E. W. Rice, Jr., as third vice-president, supplements these figures by those of an engineering character, and states that the improvements in the factory plants have increased the capacity 25 per cent. in the year. The generator and motor output in kilowatts was 380,000 or 509,000 horse-power, an increase of over 35 per cent., as compared with 1895. During the year the company have supplied, or had on order, 60,000 horse-power for apparatus for water power conversion and transmission. They built also some 30 generators of 1,000 horse-power and over, as well as some very large transformers, one for the Carborundum Company reaching 1,112 horse-power. The company protected their inventions by filing 92 applications for patents and by securing 92 patents issued to their engineers and assigned.

The report of Mr. J. P. Ord, second vice-president, is a very voluminous document, covering the financial details of operation and furnishing the company's balance sheet. It appears that the company commuted on all claims accruing under the patents and agreements with C. J. Van Depoele and J. C. Henry, and also made a full settlement with Mr. Edison of all claims under his contracts. It is also stated that the company owns seventy acres of real estate, with a total floor space in its three factories of 1,350,000 square feet. All are free from mortgage or lien. It has not been necessary to borrow money, nor has the company's credit been used for issuing notes, indorsing customers' paper for discount, or in lending their name to allied companies. There are no notes of the company out, and all purchases during the year have been paid for in cash. The average cash balance during the year has been $578,000. During the year the company has sold securities of a par value of $1,359,820 and carried as worth $514,053, for $707,399. It also sold the Schuyler factory.

The business of the year shows Gross Earnings $13,315,667, and Gross Expenses $11,910,240. Against this is a deduction

CONSOLIDATED BALANCE SHEET OF JAN. 31, 1896.

ASSETS.

Patents and Franchises			$8,000,000.00
Factory Plants			3,468,002.00
Real Estate (other than factory plants);			
Edison Bldg., N. Y. City.	$412,584.63		
Less mortgage thereon.	200,000.00		
	212,584.63		
Other Real Estate	241,000,00	$453,584.63	
Stocks and Bonds (see Schedule A)		5,478,332.23	
Notes and Accounts Receivable		6,584,123.30	
			12,517,040.16
Cash			879,685.75
Work in Progress		961,386.38	
Inventories :			
At Factories	3,418,572.60		
" Local Offices	714,540.81		
Consignments	86,770.25		
		4,219,883.66	5,181,270.04
Profit and Loss			13,917,071.48
			$43,963,069.43

LIABILITIES.

Capital Stock :		
Common	$30,460,000.00	
Preferred	4,252,000.00	
		$34,712,000.00
5% Gold Coupon Debentures		8,750,000.00
Accrued Interest on Debentures	72,916.65	
Accounts Payable	428,152.78	
		501,069.43
		$43,963,069.43

of interest due on debentures of $437,500, offset by $421,040 interest and dividends received on securities owned, leaving an amount of $16,459 to come off the gross earnings. Deduction is made also of amounts written off as follows: Patents and franchises, $159,264; factory plants, $322,339; other real estate, $29,718, making $511,321, and leaving a net of $877,645 as the reduction of the deficit of previous years.

The consolidated balance sheet for Jan. 31, 1896, is appended. It shows, as will be seen, nearly $14,000,000 under the head of profit and loss and patents and franchises carried at $8,000,000.

THE

Electrical Engineer.

Vol. XXI. APRIL 29, 1896. No. 417.

ELECTRIC TRANSPORTATION.

CAN ELECTRICITY SUPPLANT THE STEAM LOCOMOTIVE ON TRUNK RAILWAYS ?—X.

BY

Wm. Baxter Jr.

Saving in Operating Expenses of Pennsylvania Railroad by the Substitution of Electricity for Steam.

IN what has preceded, the various items on the cost of operating trunk line railroads that can be reduced by the adoption of electricity, have been discussed, and in some cases the percentage of saving that could be effected has been shown. It is far more satisfactory, however, to know what the sum total of all these savings amounts to, and this point we now propose to consider. The Pennsylvania road has been selected for this comparison, not because it offers any unusual opportunities for making a good showing for electricity, but simply because the reports of this road are given more in detail than those of any other reports that we have been able to obtain. In order to be able to make a comprehensive comparison it is necessary to analyze the different items of expenditures and show the relation between them in the two systems. This can be better accomplished with the Pennsylvania Railroad reports than with any other.

Table 13 gives the operating expenses of this road for the year 1894. On inspection of the various items of expenditure it will be seen that the following are those in which a saving can be effected by electricity, as has been shown in previous paragraphs:

1. Repairs of roadway. 2. Removals of ties. 3. Repairs of bridges and culverts. 4. Repairs and renewals of locomotives. 5. Shop machinery, tools, etc. 6. Wages of enginemen and firemen. 7. Fuel for locomotives. 8. Water supply for locomotives. 9. All other supplies for locomotives. 10. Wages of switchmen, flagmen and watchmen. 11. Expenses of telegraph, including train dispatcher and operators.

The sum of all these items that can be reduced more or less by the adoption of electricity amounts to $17,205,624.18, which is nearly 42 per cent. of the total expenses.

To further assist in determining the extent to which the items which are composed mainly of wages can be reduced, Table 14 is given. In this table not only the salary, but also the number of employés of each class is given.

Referring to Table 13, it will be seen that the cost of keeping the roadway in repair is very great. When this item and the cost of new ties are added together we find that they amount to nearly ten times the cost of new rails. Now, as already shown, the effect of the unbalanced condition of a locomotive upon the track is very great, as it shakes it sidewise and up and down. This action loosens the ballast around the ties and also works the spikes and bolts loose. The locomotives are not the cause of all the wear and tear on the roadway, but they certainly cause a very large portion of it. That this item in the expense account could be considerably reduced by using electric motors there can be no doubt. An electric motor is a perfectly balanced machine, and all the wear due to the vertical and lateral motion imparted to the track by locomotives would be done away with. That the saving would be a large percentage will be evident when we notice the small expenditure for rails compared to the cost of renewing ties and keeping the road in repair. I believe that practice would show that these two items could be reduced at least twenty per cent. The repairs to bridges could also be reduced, and probably to the same extent. Bridge engineers are well aware of the fact that the deterioration of such structures is greatly increased by vibration. It is also well known that the vibration caused by locomotives is very much greater than that caused by an equal weight of cars; in fact, it would not be unreasonable to claim that it is three or four times as great. It is difficult,. however, to form any very definite idea of the saving in cost of repairs to these structures by the removal of the excessive strain brought to bear on them by locomotives, because no information is at hand as to the relative proportion of iron, wood and masonry that enters into their construction. The class of work that deteriorates most under the stress of jars produced by the moving load is the iron. Woodwork

TABLE 13.

OPERATING EXPENSES OF PENNSYLVANIA RAILROAD, FROM REPORT OF 1894.

Maintenance of Way and Structures.	
*Repairs of roadway	$2,844,126.31
Renewals of rails	387,406.80
*Renewals of ties	806,661.98
*Repairs of bridges and culverts	899,955.67
Repairs of fences, etc	389,597.88
Repairs of buildings	898,632.22
Repairs of docks and wharves	201,226.89
Repairs of telegraph	72,190.60
Other expenses	27,406.59
	186,098.23
Total	$6,713,305.07
Maintenance of Equipment.	
*Repairs and renewals of locomotives	$2,896,735.12
Repairs and renewals of passenger cars	979,096.09
Repairs and renewals of freight cars	3,607,242.50
Repairs and renewals of ferryboats, etc	219,294.08
*Shop machinery, tools, etc	149,167.12
Other expenses	682,559.62
	60,009.73
Total	$8,594,104.26
Conducting Transportation.	
*Wages of enginemen, firemen and roundhousemen	$3,222,974.47
*Fuel for locomotives	3,724,481.14
*Water supply for locomotives	264,840.81
*All other supplies for locomotives	236,616.84
Wages of other trainmen	4,341,318.10
All other train supplies	821,684.79
*Wages of switchmen, flagmen and watchmen	1,017,118.72
*Expenses of telegraph, including train dispatchers and operators	1,142,946.05
Wages of station agents, clerks and laborers	4,614,006.31
Station supplies	574,260.24
Car mileage balance	1,046,678.39
Loss and damage	245,650.89
Injuries to persons	198,180.15
Barges, floats, ferryboats, expenses of, including coal, wages and supplies	753,407.63
Other expenses	678,266.82
Taxes	381,741.55
Total	$22,755,190.89
General Expenses.	
This includes salaries of officers, clerks, agents, etc., office expenses, advertising, insurance, legal expenses, etc., and amounts to	$2,941,199.98
Recapitulation of Expenses.	
Maintenance of Way and Structures	$6,713,305.07
Maintenance of Equipment	8,594,104.26
Conducting Transportation	22,755,190.89
General Expenses	2,941,199.98
Grand total	$41,003,800.20

Number of locomotives on Pennsylvania Road :

Passenger	478
Freight	1,103
Switching	224
Total	1,805

New locomotives added during the year : Passenger, 9 ; switching, 2.

comes next, while the effect on stone structures is so slight as to amount to nothing practically. In all probability the repairs on bridges and other girder work could be reduced ten per cent. by the use of electric motors and the consequent reduction in vibration, but a conservative estimate would probably place the figure as low as five per cent.

The next item in the line of repairs is that of locomotives, and it is the most important of all, not only because it amounts to a very large sum, but also because it is vastly greater than the corresponding expenditures in an electrically operated road could possibly be. In order to more fully show its importance it will be well to make a comparison with the cost bill, and also the relative proportion that each one constitutes of the total expenses. In this way we find that it is equal to something over 78 per cent. of the entire cost of fuel consumed by locomotives. We also find that it amounts to over seven per cent. of the total expenses of operating the road, while the fuel bill only exceeds it by two per cent.

In most all of the calculations that electrical engineers have made on the subject of substituting electricity for steam on trunk line railroads, the main effort has been to show that a great saving could be made in cost, and that this gain would be enough to render the adoption of the system desirable from a financial standpoint. But here we see that we have an item nearly as large as the

TABLE 14.

EMPLOYÉS AND SALARIES.

Class.	Number.	Total yearly compensation.	Av. daily compensation.
General Officers	35	$279,700.00	......
Other Officers	211	493,594.80	......
General Office Clerks	1,739	1,514,249.66	$2.42
Station Agents	805	418,738.00	1.73
Other Stationmen	6,088	3,237,310.86	1.70
Enginemen	1,843	2,049,116.25	3.75
Firemen	1,919	1,120,348.80	1.92
Conductors	1,440	1,394,865.36	3.24
Other Trainmen	5,194	2,749,008.08	1.82
Machinists	2,494	1,843,999.11	2.51
Carpenters	2,941	1,769,578.10	2.10
Other Shopmen	4,867	2,429,137.08	1.71
Section Foremen	615	342,118.20	1.70
Other Trackmen	8,250	3,109,461.30	1.10
Switchmen, Flagmen and Watchmen	2,295	1,112,654.57	1.60
Telegraph Operators and Dispatchers	1,595	972,356.85	2.15
Employés, Account Floating Equipment	540	373,397.04	2.32
All other Employés and Laborers	6,130	2,400,508.60	1.40
Total	49,001	$27,610,222.66	$1.84

DISTRIBUTION OF ABOVE.

General Administration	2,110	$2,361,419.46	$3.10
Maintenance of Way and Structures	11,674	4,709,019.97	1.23
Maintenance of Equipment	12,708	6,875,171.94	1.87
Conducting Transportation	22,509	13,664,611.29	2.03
Total	49,001	$27,610,222.66	$1.84

coal and one which, from the very nature of things, can be reduced enormously by the substitution of electric motors for locomotives. In order to show that the claims here made are not unreasonable it will be well to quote one of the best authorities on the subject of steam locomotives, Mr. Arthur Wellington. In speaking of the cost of locomotive repairs and their apportionment to the various parts, he gives the following figures: Boiler, 20 per cent.; running gear, 20 per cent.; machinery, 30 per cent.; lagging of boiler and painting, 12 per cent.; smokebox, etc., 5 per cent.; tender, 13 per cent.

Looking over these figures we see at once that some of them would disappear completely in an estimate of the repairs of electric motors, because those parts are not used with the latter, nor is there anything to take their place. Those parts that would be struck out would be: Boiler repairs, 20 per cent.; running gear, 20 per cent.; lagging and painting, 12 per cent.; smokebox, etc., 5 per cent.; tender, 13 per cent., making a total of 70 per cent. of the entire cost of repairs to locomotives. It may be claimed that to strike out the repairs of running gear is not proper, as this part of the machine is used with electric motors as well as in locomotives, but if the motors are placed on the trucks of a car, then the only increase in cost of repairs on such trucks would be the cost of keeping up the motors, and this, therefore, is the only charge that can be justly made against the motor, as the expense of maintaining the trucks would be the same whether motors were used or not.

NEWS AND NOTES.

CONTEMPORARY ELECTRICAL SCIENCE.

The management of electrical waves is making rapid progress. Herr von Lang, "Wiedemann's Annalen," describes Quincke's familiar apparatus for showing the interference of sound waves through two branches of a tube of unequal length, except that electric waves are substituted for sound waves. As the length of one of the branches is varied, distinct maxima and minima are shown by the "coherer" employed for their detection. Filling one of the branches with another dielectric such as paraffin or sulphur enables the observer to determine the velocity of the waves in those substances, and hence their refractive indices. They come out rather higher than usual.—L. Zehnder gives one more rule for the directions and signs of the various occurrences in the electromagnetic field. It is perfectly general and very simple in form, but its appl cation seems to require profound study.—Joseph von Gietler examines the wave systems given out by the more complicated forms of Hertz generators. He finds that for every length of the secondary circuit the primary circuit emits several wave circuits of different thicknesses and intensities. He determines these intensities by means of resonators.—W. Holtz recalls that in 1889 he found that conductors were more opaque to the electric glow discharge than dielectrics. This result was at the time so "absurd" that he began to doubt it himself. It has now been made very probable by Röntgen's discoveries. Herr Holtz calls upon physicists to make further experiments in this direction, being himself prevented by illness from doing so.

DR. LODGE'S EXPERIMENTS IN ROENTGEN RAYS.

Dr. Oliver Lodge puts it on record in the "Times" that during the past ten days he has seen fluorescence excited by Röntgen rays after they had penetrated the bodies of two men, standing one behind the other, in their clothes. Also he and his co-workers have succeeded in radiographing the details of a damaged vertebra in the spine of an adult patient at the Northern Hospital, Liverpool, with an exposure of half an hour, and found a "Murphy-button" in the intestine of another adult at the Liverpool Royal Infirmary with an exposure of ten minutes. A focus tube and a powerful ordinary induction coil were the means used.

ROENTGEN RAYS AT THE ACADEMIE DES SCIENCES.

The "Comptes Rendus" for March contains no fewer than twelve communications relating to X-rays. M. A. Lafay describes the following experiment: Underneath a Crookes tube, about ½ centimetre from the most brilliant portion, he ar ranged a leaden screen pierced by a slit 2 millimetres wide. Some 4 centimetres lower he placed a second lead screen pierced by a 5-millimetre slit, completely closed by a very thin strip of silver foil supporting a platinum wire 1.5 millimetres in diameter, exactly in the axis of the slit. The silver foil was connected to the negative pole of the induction coil. The rays then passed between the poles of an electromagnet, capable of generating a field of 400 C. G. S. units, the lines being parallel to the slit. In the first experiment M. Lafay, with a sensitive plate, 8 centimetres away from the poles of the electromagnet, obtained no certain trace of deflection. With the plate 15 centimetres off, however, there were unmistakable evidences of deflection of the rays in the same direction as would be the case with cathode rays.

QUAKERTON, PA.—Mr. Gottlieb Frey, the city electrician and superintendent of the electric light department of the borough of Quakerton, Pa., informs us that a company is being organized there to construct and operate a telephone and fire alarm system. He is himself interested, and will do all he can to promote this needed improvement.

THE VOLTA ELECTRIC COMPANY, of New York City, has been formed with a capital stock of $10,000. The directors are Paul A. Curtis, E. W. Curtis, and John Potts.

ERIE CANAL.—It is rumored that $2,000,000 foreign capital has been offered for the right of operating on the Erie Canal by electric traction.

CANTON, MISS.—Mr. E. A. Stimson, superintendent, reports that contractors are at work on an extensive system of water works and electric lights. The old central station is being enlarged, and Canton will soon rank with the best towns in the State in water and electrical service.

ELECTRIC LIGHTING.

HIGH VOLTAGE LAMPS AND THEIR INFLUENCE IN CENTRAL STATION PRACTICE.—III.

BY G. E. ADDENBROOKE, M. I. E. E.

IT is generally acknowledged that in the three-wire system at 110 volts it is not economical or very practical to distribute current at a radius of much more than three-quarters of a mile from the central station, except under special circumstances. The area which can therefore be economically served from such a station is about one and a half miles each way, or about two and a quarter square miles. In his well-known feeder paper Mr. Crompton gave figures which he argued showed that a feeder on the three-wire system supplying 110-volt lamps could be laid and maintained, and would involve the same loss of energy, taken over the same day, as would an alternating feeder, including transformers, instruments, and switching gear, the length of the feeders in each case being 2,400 yards. These figures were strongly attacked by the alternating party, myself amongst the number; the most legitimate point of attack being that Mr. Crompton had assumed a loss of 30 per cent. at full load on the low-pressure feeder, which was considered excessive on account of the extra plant it would entail at the central station. Had Mr. Crompton put the length of his feeder at about 1,400 yards, or a little over three-quarters of a mile, and had he used a density of about 500 amperes per square inch—which is about the practical density—the loss would have been 16 per cent. for the continuous current feeder at full load, and few alternating men would have seriously combated that on the whole the continuous-current feeder was as economical and desirable as an alternating feeder. The figures would then agree with the generally current comparison which I have mentioned above, and which I propose to use as a basis of argument in order to avoid disputes.

Now, from data I have collected, it appears that in such places as the center of large towns there are perhaps 30,000 inhabitants per square mile, though ordinarily the population for a square mile of a town does not appear to exceed 16,000. A low-pressure station on the three-wire system with 110-volt lamps can therefore serve economically about 60,000 to 70,000 people in the centers of large towns, and about 35,000 in districts outside the centers and in provincial towns. If, therefore, we wished to light London, with its 4,000,000 population, on this basis, taking the average population at 25,000 per square mile, we should need, roughly, 70 to 80 stations to light the whole metropolis, not counting the extreme suburbs.

If, however, in the direct supply system the voltage is double, the position is altogether altered, and a comparison between the transformer and direct supply systems under these circumstances will lead to very different results from those so far given. Theoretically, if 220-volt lamps are used, we can extend the feeders four times as far as if 110-volt lamps are employed, and therefore the area which could be lighted from each station is 16 times as large. I do not intend to take full advantage of this facility in the calculations which I propose to lay before you, as I consider that the fall of voltage is too large in low-pressure central stations at present, and that the voltage of the lamps at different points of the distributing system is not kept as near the normal as it should be. In what I am about to say I shall therefore consider that, instead of four times, we extend our feeders a little over three times as far as before, thus securing better regulation and a smaller percentage drop in both the feeders and distributing system, together with the great saving in copper. If, then, we can extend the lighting radius three-quarters of a mile from a low-pressure direct supply station with 110-volt lamps, we can extend it, on the above basis, 2½ miles at 220 volts, which means that we can cover an area of 5 × 5, or nearly 25 square miles from one station—that is, 11 times the area we could before. Instead, therefore, of serving 60,000 people in the central districts, one central station would serve 700,000, and over a quarter of a million in the less central districts. Taking, then, the population of London as 4,000,000 without extreme suburbs about six or seven stations would comfortably cover the whole area. Now this is a number which is directly comparable with the number of stations at present being operated by the gas companies; and to my mind it is doubtful if it would be desirable to reduce the number of stations below this figure for so large an area, even if it could be managed.

It would be interesting to go into this metropolitan lighting problem further did time permit, but it does not, and I must ask you now to turn your attention to the provinces. Take maps of Birmingham, Liverpool, Glasgow and Manchester, and cut out a piece of tracing paper to represent 25 square miles on the same scale as the map. Lay the tracing paper over these maps, and you will find that two stations, or at most three, will cover not only the whole of these great cities, but the suburbs for a couple of miles outside. For the general run of large towns one station would amply suffice; and for the smaller ones one station would, of course, permit of lighting over the whole area at a very small expense for mains. Before a technical audience like this, however, it will doubtless be more satisfactory to investigate a particular instance than to proceed further with general statements.

At 220 volts pressure an ampere represents 220 watts; therefore, one-third ampere represents 73.3 watts. Now at 4 watts per candle power a 16-c.-p. lamp takes 16 × 4 = 64 watts, and an 8-c.-p. lamp 32 watts. We shall therefore be sufficiently near for the purposes of this calculation, and shall be allowing a sufficient margin, if we assume that a 16-candle lamp takes one-third ampere, and an 8-candle lamp one-sixth ampere at 220 volts.

Next consider the distributive system. There are two points needing attention: the first is, How far, and over what area, can we spread our network from the feeder points? The second is, What drop should we allow on the feeders themselves?

But before going into these matters further we must settle what shall be our greatest drop from the feeder point to our furthest lamp on the network spreading from it. The variations which are permitted at present are too great, and would have to be reduced in time anyhow. I therefore do not intend to adopt the present practice as a basis, but to take as the limit an extreme fall of 2 per cent. on the distributing system from the feeder point to the furthest lamp at the tops of the houses; that is, lamps near the feeder would be 1 per cent. above their proper voltage at full load, and extreme lamps 1 per cent. below. This is, I think, as large a variation as good practice would allow, though it is less than half what is considered permissible now. Having settled this, the following data and table will enable us to see at a glance the best method of designing the mains and their cost.

1. A bar of copper 1 in. in section and 1 mile long weighs approximately 9 tons, and its resistance is $^1/_{22}$ of an ohm, or 0.045.

2. Therefore a double conductor 1 mile long and 1 in. in section weighs 18 tons, and its resistance is $^1/_{11}$ of an ohm, or 0.090.

3. I do not think it will be necessary on the high-voltage system to have the third wire in a three-wire system more than one-fifth the section of the other two, except, perhaps, in the distributing system. In fact, I understand Mr. Crompton considers the third wire could be done away with altogether as soon as the feeder gets a good load joined up to it, so that only the distributing system would need the third wire, these wires being joined together at the distributing point.

Consequently, the weight of a set of mains on the three-wire system—the two outers 1 in. section, and the inner one-fifth of an inch—would be 20 tons per mile; and the cost for copper at 6½d. per pound, would be £1,210 in the mile of mains. Now at 1,000 amperes per square inch a main this size would carry current for 6,000 16-c.-p. lamps, if perfectly balanced on the above basis, and the fall of pressure would be 90 volts in the mile, or 17 per cent. Such a fall of potential as 17 per cent. in the mile is excessive, and therefore we must arrange to work at a smaller current-density.

To enable the best current-density to be judged I have arranged the following Table I.:

TABLE I.

DATA RELATING TO FEEDERS ON THREE-WIRE SYSTEM SUPPLYING 220-VOLT LAMPS—$^1/_3$ AMPERE PER 16-C. P. AND $^1/_6$ AMPERE PER 8-C. P. LAMP.

Current density in amperes per sq. in.	Loss in volts per mile of double conductor.	Percentage fall of potential at full load.	Kilowatts available per sq. in. section of outers = 2.2 sq. in. copper.	Number of lamps carried by mains 1 sq. in. section = 2.2 sq. in. copper.		Cost per mile of copper at 6½d. per lb.			
						Per lamp alight at once.		Per lamp installed = twice lamps alight.	
				16 c. p.	8 c. p.	16 c.p.	8 c.p.	16 c.p.	8 c.p.
		%				s. d.	s. d.	s. d.	s. d.
1,000	90.0	17.0	440	6,000	12,000	4 0	2 0	2 0	1 0
500	45.0	9.3	220	3,000	6,000	8 0	4 0	4 0	2 0
400	36.0	7.6	176	2,400	4,800	10 0	5 0	5 0	2 6
300	27.0	5.8	132	1,800	3,600	13 5	6 8	6 0	3 4
250	22.5	4.86	110	1,500	3,000	16 0	8 0	8 0	4 0
200	18.0	3.85	88	1,200	2,400	20 0	10 0	10 0	5 0

This table enables us to see the reduction in fall of potential which we get by reducing the current for a given section, and

also the cost for copper which will be incurred for such density per mile run.

Now it is not unusual in some low-pressure central stations to have falls of even more than 16 per cent. at full load on the longest feeder; but this is an undesirably great fall, save on exceptional occasions, such as Christmas week, or during a fog in winter, and I think, with the immense reduction in copper cost which the use of high-voltage lamps gives, it is desirable to work with smaller falls. Suppose we accept 250 amperes per square inch as a basis, it will be seen that mains on the three-wire system will cost us 16s. per 16-c.-p. lamp alight at once, and 8s. per 8-c.-p. lamp per mile, and the drop of potential will nearly be 5 per cent. Now, if we assume that current is supplied 2½ miles from the stations as an extreme, as we did before, our longest feeders will be about this length, the drop at full load on the feeder will be about 12 per cent., and the cost of copper 40s. per 16-c.-p. lamp, and 20s. per 8-c.-p. lamp alight at once for the longest feeder.

If we take the network as proceeding from the feeder points at the same current-density—namely, 250 amperes per square inch—and if we agree that it shall extend rather over a quarter of a mile from the feeder point, to allow for irregularities, so that each feeder will feed a network covering half a mile square, it will be noted that the drop, including extra lengths of main for going round angles and into the houses, will be about 1½ per cent., and the extreme cost of copper per lamp alight at one time in the network will hardly be more than 4s. per 16-c.-p. lamp, and 2s. for an 8-c.-p. lamp, while the mean cost will be about three-fourths of this, and the mean drop of potential only 1 per cent.—and even this can readily be reduced by a little judicious adjustment.

We therefore see that for feeders extending about 2¼ miles, and a network extending a quarter of a mile further from the feeding point—that is, 2½ miles altogether—the extreme cost for copper per 16-c.-p. lamp lighted at once will be about 44s., and for an 8 c.-p. lamp under 22s.

This represents extreme lengths. The average length of feeders to cover the above area would hardly be more than 1¾ miles, or three-fourths of the above maxima, and the cost of the copper, on the average, in the distributing system will be reduced in like proportion. We shall therefore be correct in taking three-fourths of the above sums as the average cost of copper per lamp lighted at once from station to lamp, including both feeder and network, in a station covering a town area of equal density 25 square miles in area. This is, approximately: Per 16-c.-p. lamp, 33s.; per 8-c.-p. lamp, 16s. 6d. Further, from practice and the tables in "Lightning," we know that there are usually at least twice as many lamps installed as are required alight at once; therefore we may put the capital cost of mains for copper once at about: Per lamp installed —cost of copper, 16-c.-p., 16s.; 8-c.-p., 8s.·3d.

Now it is fair to take 6 per cent. per annum as the sum to allow for interest and depreciation on the copper in the mains —say 3½ per cent. for interest, and 2½ per cent. for depreciation. At this rate, on the above capital cost, the annual cost for interest and upkeep comes out at under 1 shilling per 16 c.-p. lamp, and 6d. per 8 c.-p. lamp installed.

Further, on looking through the tables of consumption of current, it will be found that 18 units per 8-candle lamp installed is a fair all-round average—at least, it is the average from "Lightning" for London and most of the provincial stations. At this rate, therefore, it will be seen that the upkeep and interest on capital for the copper in the distributing system comes to 0.33d., or one-third of a penny per unit of current sold; or, supposing the sum actually received for current is 6d. per unit, the cost for interest and upkeep on the copper in the distributing system represents less than 6 per cent. of the cost of current. Out of this cost it will be noticed that about three-fourths of the copper is in the feeders and one-fourth in the distributing system.

X-RAY PICTURES WITHOUT PHOTOGRAPHY.

Righi describes, in "L'Electricien," an apparatus by which he obtains the Röntgen pictures without the use of the photographic plate by a method similar to that employed by Lichtenberg and Kundt. Under the Crookes tube is fixed a sheet of black cardboard, backed by a sheet of aluminum, which is connected to earth. Below this is fixed a sheet of ebonite, backed with tinfoil, which latter is connected through an air condenser to the cathode of the tube. The anode of the tube is also put to earth. If a hand is now laid on the cardboard, and subjected for a sufficient time to the action of the tube, it will be found that an electrical picture of the hand à la Röntgen has been imprinted on the sheet of ebonite. This can be made visible by the well-known mixture of sulphur and red lead, or by another mixture of talc and dioxide of magnesium, which gives an effect more closely resembling a photograph. The bones, etc., are shown in these electrographs just the same as in the Röntgen photographs.

ROENTGEN RAYS.[1]

BY PROF. HENRY MORTON.

In connection with Dr. Röntgen's discovery and the X-rays, there are a number of facts long known which in some cases seem to be forgotten, and which, while in no way detracting from the originality and merit of his discovery, yet need to be considered in order that the true characteristics of this discovery should be recognized, and the mixed or uncertain character of many experiments recently made by others in attempting to repeat or extend his results, clearly appreciated.

Thus to begin with, it is not new that invisible radiations obtained by electrical discharges in Geissler tubes and elsewhere, should produce photographic and fluorescent effects. In the "American Journal of Art and Science," 1864, vol. 37, p. 207, will be found a paper by Prof. O. N. Rood, of Columbia College, entitled "On the Action of Very Weak Electric Light on the Iodized Plate." From this paper I will make a few quotations:

"About three years ago Dove received from Mr. Gunther, of Berlin, a photograph of a bronze statue of an Amazon holding a lance in a perpendicular position, Mr. G. at the same time calling his attention to a singular mark in the picture, which was not in the original."

"The lance was properly delineated on the negative plate, but in addition just at the tip, a dark streak was visible, though nothing of the kind had been observed at the time of taking the picture. Careful examination of the plate showed two other analogous marks. Dove thought that these singular appearances might have been caused by the presence of invisible electric brushes, resting on these points, and undertook some experiments to determine whether weak electric light could be photographed. Geisler tubes were used in a dark room and with the aid of Gunther he succeeded in obtaining good photographs of the stratified discharge."

Professor Rood then goes on to describe further experiments of his own, made to ascertain if these faint electric lights or discharges could be photographed in a light room and when they were invisible to the eye. After describing some preliminary trials he further says: "Accordingly, to make an exact experiment on this point, a sheet of white paper was placed behind one of these" (Geissler) "tubes and white light reflected through it towards the camera. The intensity of this reflection was so regulated that the bright envelope of platinum wire" (in the tube) "was nearly invisible, and the diffused violet light at a greater distance from the wire, absolutely invisible. Nevertheless an intense photographic image of the envelope, and a very distinct image of the diffused electric light was easily obtained, thus proving conclusively the correctness of Dove's assumption that electric light, which in ordinary daylight could not be seen, owing to its feeble illuminating power, might yet make itself very evident on the iodized plate, by virtue of its high percentage of chemical rays."

The above is interesting as showing that as early as 1864 the relatively greater photographic than visual effect of the light produced in exhausted tubes (Geissler tubes) was recognized.

About the same time and thereafter, and indeed up to the present day, much work has been done in photographing that part of the solar spectrum which represents those vibrations which by reason of their short wave-length have either little effect upon the eye or none at all.

Prof. Wm. A. Miller[2] in London carried this work far enough to show that he could, by the use of quartz lenses and prisms, secure a photographic spectrum from the electric light extending beyond the visible violet for a distance several times as great as separated the extreme violet from the lowest visible red, at the other end of the visible spectrum. It was thus shown that invisible radiations of short wave-length possessed remarkable photographic power.

I will now turn to another line of observation which marks a limitation or distinction of the Röntgen effects in another direction. When the eye is directed towards a faintly luminous object it will either at once perceive it (under favorable conditions) or not at all. In other words, nothing will be gained by continually gazing at it. On the contrary, the best chance of catching sight of a faint object, such as a feebly luminous comet, is to look away from the true direction and then, with some quickness, to turn the eyes towards it. In this way we can often secure a momentary impression of a dim object which we cannot perceive continuously. With the sensitive photographic plate, however, all this is reversed. An amount of light which, acting on a plate for one second, pro-

[1] From the "Stevens Indicator."

[2] See "Phil. Trans." of Royal Society, 1862.

duces no sensible impression will produce a strong one if its action is continued for twenty or thirty seconds, and so on up to several hours of exposure. One of the most interesting illustrations of this has been furnished in connection with the photographing of stars carried on at the Harvard Observatory, under the Henry Draper Memorial, maintained by Mrs. Henry Draper, of New York; but the first observation of this phenomenon was made by Mr. A. A. Common, of England, in connection with his beautiful photograph of the nebula in Orion. It was there found that, besides the impressions of visible stars on plates exposed for a long time, there were many other similar spots or images occurring time after time, in the same positions on successive plates, which were due to stars too faint to be perceived by the eye, but yet capable, by prolonged action, of producing images on the sensitive plates.

We see, then, that the photographic plate has yet another means of seeing in the dark, besides that due to its power of perceiving vibrations whose wave-length is too short to affect the nerves of the retina. By its accumulative action or capacity of storing up the effects of any sort of vibrations capable of affecting it, rays too feeble to affect the eye will, in time, impress the sensitive film.

There is yet another region of observation which should be marked off in order to appreciate fully the nature of the Röntgen discovery. When in August of 1880, Dr. A. G. Bell announced his remarkable invention of the photophone, by means of which sounds and articulate speech could be conveyed from one place to another by a pencil of light, he stated at the same time that the radiant vibrations of sunlight by which this result was secured were only to a moderate extent impeded by a sheet of hard rubber thick enough to shut out to the eye every trace of light even from the concentrated rays of the sun.

It had also been noticed some time ago by others that a sheet of hard rubber was not a perfect shield for a sensitive plate if there was any considerable exposure to sunlight. (See also Photography of the Infra-red region of the Solar Spectrum. W. H. Pickering, Ph. D., "Pro. Am. Acad. of Arts and Sciences," 1864.) Moreover, Carey Lea, of Philadelphia, more than twenty-five years ago showed that a negative plate could be so acted upon as to develop an image, on applying the usual developer, by the application of very moderate heat and even of slight mechanical pressure. (See his Manual of Photograhy, 2d Edition, 1871, p. 408.)This last is of special interest in connection with Tesla's recent suggestion that the Röntgen pictures may be due to the mechanical action of the impact of particles actually driven at high velocities from the cathode pole.

While the above facts detract nothing from the originality and merit of Dr. Röntgen's real discovery, they are of use in helping us to appreciate what is its important and central characteristic and to discriminate between the same and many of the so-called repetitions and extensions of his work with which the daily papers have been filled. The Röntgen discovery differs from all that went before, not in the broad fact that some sorts of radiation would act on sensitive plates when by passing through certain screens or otherwise they had become or were invisible, but in that this investigator has shown a new sort of vibrations absolutely devoid of luminous properties and yet capable of easily penetrating certain materials of the greatest optical opacity, such as black paper.

The experimenters who have been producing shadow photographs with sunlight, electric lights, and the like have not been repeating Röntgen's operations, but only applying facts known for fifteen or more years. There is another part of Röntgen's work which, though followed up by some, has as yet excited much less general attention, partly no doubt because the materials and conditions for making experiments are less easy to secure, and also because the results are not permanent, but must be inspected while they are being produced. I allude to the developments of fluorescence and the production of shadow pictures visible on a fluorescent screen.

To make this subject clear, and, as before, to bring out the exact novelty of Röntgen's work in this connection also, I must go into the early history of the subject of fluorescence. This was first systematically studied by Professor Stokes, of Cambridge, England, and admirably developed in his classical paper in the "Philosophical Transactions" for 1852, Part 2, p. 466, et seq. In this place he shows that quite a number of solid bodies and solutions possess the power of absorbing light vibrations of various wave-lengths and then instantly emitting them again, but always with an increase of wave-length. Thus, for example, a solution of acid sulphate of quinine will absorb the extreme violet rays of the spectrum, and then emit them as bright blue rays. Again, an alcoholic solution of chlorophyl (the coloring matter of plants) will absorb yellow rays, as well as shorter ones, and emit red light. There are many other bodies acting on and producing different rays, but in every case the emitted ray is of greater wave-length, or as we may say, lower in the spectrum than the absorbed or exciting ray.

As might naturally be expected on this principle, the extremely short wave-lengths of rays above the visible violet of the spectrum causes them to be absorbed by most fluorescent bodies, and emitted as rays of greater wave-length and therefore visible, and thus in this way, also, was supplied a method of making invisible light of solar vibrations visible. In fact, Stokes showed that if a solar spectrum was thrown on a block of "canary glass" (glass colored greenish yellow by oxide of uranium) its upper end was elongated or rendered visible by the fluorescent light developed, just as it was similarly extended upward when photographed upon a sensitive plate.

Besides canary glass many other materials could be used, the most efficient being a sheet of paper coated with a paint made from finely pulverized crystals of the platino-cyanide of barium. This subject was further investigated in this special relation by Stokes and also by Miller in 1862. (See Phil. Trans., 1862.) In 1872 the present writer had the good fortune to discover in and extract from certain dense and tarry petroleum distillates a hydrocarbon to which he gave the name Thallene, which possessed this property of fluorescence in a pre-eminent degree. Itself of a light lemon-yellow color if spread as a pigment on paper, it shines out with a flood of grass-green light when placed in an invisible part of the spectrum or when there fell upon it violet or blue light. Its peculiar properties were exhibited at a lecture on Fluorescence, delivered in the Academy of Music, in Philadelphia, in 1872, in the following manner:

A screen or curtain, about twenty feet square, of muslin of the yellow color of Thallene, was prepared, and to this was attached a design of leaves, wreathes, etc., made of paper coated with Thallene. Seen by gaslight this design could not even be recognized at a short distance, but when the rays of a powerful electric light, sifted through a dark purple glass which cut off all but the violet and super-violet radiations, were thrown on it the design fairly blazed out in vivid green on a background of muslin, which looked as dark as black velvet. The yellow muslin could not reflect any of even the violet light, but the Thallene turned this, as well as the super-violet invisible rays, into green light. A full account of this material will be found, among other publications, in "The Chemical News," of London, 1872, vol. 2, p. 272; The London and Edinburgh "Philosophical Magazine," 1873, vol. 45, p. 89, and the "American Chemist," 1873, vol. 3, pp, 81 and 162. The general subject of "fluorescence" is also discussed at some length by the present writer in the article under this heading in Johnson's American Encyclopædia.

Here, then, we see, that prior to Röntgen's experiments, it was well known that certain practically invisible rays could produce visible effects through the action of "fluorescence." What Röntgen has added to this is the knowledge that such rays are developed in peculiar abundance in the highly exhausted tubes known as "Crookes Tubes," and that they will penetrate with unexpected facility a great many optically opaque substances. Just what is the distinguishing character of these peculiarly actinic and fluorescogenic rays is at present a problem enshrouded in great obscurity, by reason of the conflicting statements of experimenters.

Röntgen and others say that they proceed from the cathode terminal. Professor Rowland and others say that they come from the anode. Tesla thinks that they are not vibrations of any sort, but are streams of projected material particles.

It would seem that the judicious course is to build no theories, but to extend experiments and accumulate facts. This is being done by various able and experienced investigators who have not been in haste to publish the incomplete results of their work. Among these we would refer to Prof. O. N. Rood, of Columbia College, New York, and Prof. A. M. Mayer, of the Stevens Institute of Technology, New Jersey. Among their interesting results is an absolute demonstration that the X-rays are incapable of polarization. This property was indicated by Professor Röntgen in his original publication, but not positively established, and is of great importance as radically distinguishing the new radiation from any known variety of heat, light or actinic vibrations.

HOW WIDELY THE "ENGINEER" CIRCULATES.

It may be of interest to you to know that we have received an inquiry for bi-metallic wire from Catanzaro, Italy, the writer having seen our advertisement in The Electrical Engineer.

BI-METALLIC ELECTRIC TRANSMISSION CO.
New York City, April 16, 1896.

RECENT DEVELOPMENTS IN VACUUM TUBE LIGHTING.[1]

BY D. MC FARLAN MOORE.

MOST people have been accustomed to oil lamps, gas jets and other forms of light which have about reached their perfection. With the appearance of the arc and incandescent lamps it was thought that electricity had reached its limit in giving to the world a system of illumination that would leave nothing more to be desired. Indeed, it seems almost a presumption to dare to think of light being produced that would approach daylight in form and quality. The time is not so very remote when any man who would have attempted to

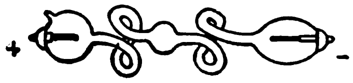


FIG. 1.

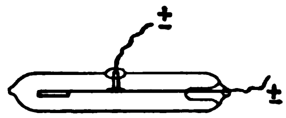


FIG. 2.

manufacture sunshine would have shared the fate of a Galileo.

But fortunately the investigator of to-day has nothing of this kind to fear. Much arduous labor has already been expended in the solution of the problem by many eminent electrical scientists engaged in the study of vacuum tube phenomena, but the results from a practical point of view have been very meager. This is chiefly owing to the complicated and expensive apparatus necessary, and the very unsatisfactory results even then obtainable. In fact, light from vacuum tubes, which is the only form of illumination that actually approaches nature's standard—daylight, has never been obtained in any quantity that would, in any way, be suitable for practical use. Of the other forms of electric lighting, the incandescent lamp is the most prominent. It is the peer of all

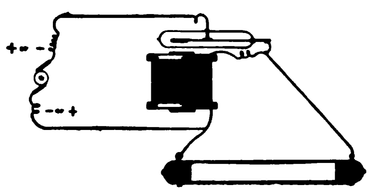


FIG. 3.

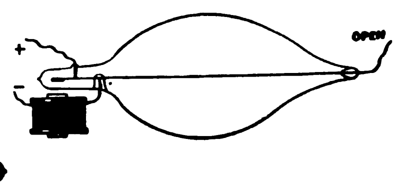


FIG. 4.

illuminants in commercial use to-day, but is lacking, when we consider maximum uniformity in the distribution of light, and when calculations show that only three-tenths of 1 per cent. of the energy of the coal necessary to produce light by incandescence (its name defines its character) is actually transformed into light, it is evident that there is room for improvement. The new electric light should possess all the good qualities of the present lamp with none of its drawbacks, and among its improvements will be noted the combination of utility and decoration. The recognized tendency of the day is toward multiplication of lights and avoidance of strong shadows—in other words, an even illumination, that is, light from all directions.

The object of this paper is not only to call attention to the advantages that will accrue with the adoption of vacuum tube lighting, but more particularly to a simple method of obtaining a current which will ultimately make such an

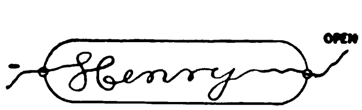


FIG. 5.

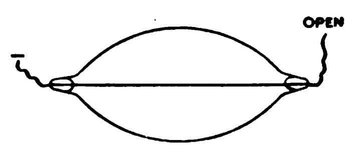


FIG. 6.

adoption universally feasible. Almost without exception, experimenters in vacuum tube lighting have hitherto sought for the solution of the proмem by merely pushing to extreme well-established methods based on principles long known in the art. That is, strictly speaking, no radical departures from the well-beaten paths have been as yet brought forward. However, this paper does represent radical departures: in principles, in apparatus and in the nature of the current, resulting in a light of greatly increased intensity.

[1] Read at the meeting of the Am. Inst. Elec. Engrs. April 22, 1896.

Before entering upon a description of the new system, permit me to call your attention to the methods heretofore used for obtaining light from hermetically sealed glass tubes containing a rarefied gas.

For many years the Geissler tube has been a scientific toy. When a suitable electric current is connected to its terminals, its entire length is filled with a faint glow. This is, of course, a light of radically different character from that now used in any commercial form of illumination. (See Fig. 1.)

It is light emanating from rarefied air with an apparent absence of heat and combustion. Upon this principle developed, probably depends the light of the future, which will soon be, in the opinion of the writer, the "light of the present." As a device for transforming electrical energy into light, the vacuum tube is very efficient. The majority of authorities place it at about 70 per cent. and the incandescent lamp at 2 per cent. Notwithstanding this remarkable efficiency, it has never been commercially possible to illuminate by vacuum tubes, because the light could not be made sufficiently intense (this is expressing it mildly) even with bulky apparatus that was entirely impracticable.

Furthermore, the current produced by such apparatus was of such a nature as to render its insulation extremely difficult. The ordinary induction coil is often used for this purpose. A current of low voltage, such as that from a battery of a few cells, must be used with such a coil, because a current of higher voltage could not be properly disrupted, the arc forming preventing a sudden break of the current. But since the light depends on the suddenness of the break, the arc must be prevented, therefore the quicker the break, the brighter the light—provided the apparatus is properly designed.

The quickest break can be made by interposing in a circuit the most perfect dielectric in the minimum space of time. The best dielectric known is a vacuum, and I have discovered methods for interposing it in rapid succession in a current in a minimum space of time, depending upon the principle of making and breaking a current rapidly in a vacuum.

The disruption of any current in the air results in the formation of a spark of greater of less length, and the greater its length, the less sudden the break. Therefore, if the break be made in a vacuum, the narrowest conceivable complete gap in the metallic conductor results in an almost instantaneous discontinuance of current, insuring a maximum e. e. m. f. The current is thus interrupted in an almost infinitely short space of time as compared with all the ingenious mechanical contrivances, such as air-blasts and magnetic blow-outs devised for the purpose of breaking a current suddenly in the open air, but all of which are of little avail for the production of any quantity of light.

The vacuum vibrator, as shown in Fig. 2, is the nucleus of my invention. Although an exceedingly small device (not as large as one's finger) it demonstrates when in circuit with a small magnet (not as large as a teacup), a principle embodying great possibilities. It is a new piece of apparatus, exemplifying a principle of value not only applicable in practical use, but also an improved implement for scientific investigation.

It is almost unnecessary to describe such a simple piece of apparatus, which consists merely of a spring rigidly supported at one end, and having attached to its free end a small disc of soft iron. A contact point rests against the spring at about its center. A sealed glass tube, from which the air is exhausted, incloses both spring and contact point. The system, as a whole, is exceedingly simple. An electric current passes through a coil of wire and then through the vacuum vibrator. Wires in contact with the outside of each of the ends of a

closed and empty glass tube are attached to the two ends of the coil of wire. This statement embodies the gist of the invention. (Fig. 3.) It will be noticed that this system is far simpler than the apparatus ordinarily used to excite Geissler tubes. The secondary coil is absent, reducing the expense and bulk manyfold, as are also the metallic terminals sealed into the ends of the Geissler tube, but it produces light, the desideratum, in wonderfully increased volume.

With this apparatus, currents of almost any voltage can be rapidly and suddenly interrupted, and it is therefore now possible to obtain by using ordinary commercial currents, strong light in vacuum tubes.

When the circuit through the magnet and vibrator is closed,

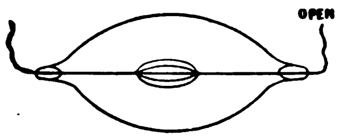


FIG. 7.

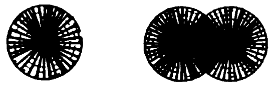


FIG. 8.

the armature within the vacuum vibrates rapidly, disrupting the current within the vacuum at each vibration.

The resulting high tension current excites a brilliant luminosity in another tube, usually of much larger dimensions, and containing a lower vacuum than the vibrator tube. There is, therefore, a necessity for two vacuums, one the very highest, the other very low. However, I have tried a number of experiments, using but one vacuum, practically amounting to an enlargement of the vibrator tube and a lowering of its vacuum. (See Fig. 4.)

This is manifestly not a good plan for the production of light, because the breaking of the current does not occur in a high vacuum, but it led to an interesting line of experiments, the most novel of which will now be brought to your attention.

Within this low vacuum is placed a wire which can be bent

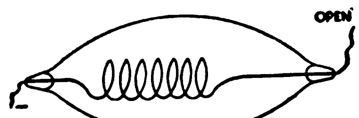


FIG. 9.

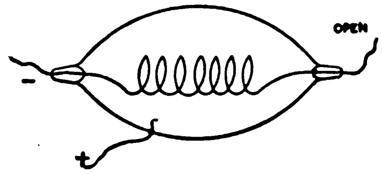


FIG. 10.

and shaped into any form desired, as shown in Fig. 5. When connected to the vibrator, the beautiful effect is immediately apparent, the wire being enveloped in a delicate purple glow. This can be applied to various purposes, such as advertising. One wire only connects this sign tube to the vibrator, and it is attached to the armature terminal of the vibrator, because when so connected, it is the one which receives the high potential discharge of the magnet. In the bulb now shown (Fig. 6), the vacuum is higher, and a single wire extends through the center. The light, instead of appearing as a purple envelope around the wire, now fills the entire chamber with a beautiful milky glow.

Close inspection, however, reveals the fact that there is a very small dark space immediately encircling the wire, and beyond it there appear to be rapidly moving rings of light, concentric with it. In fact, one is reminded of the field of

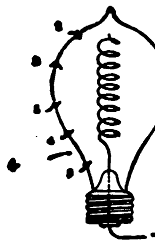


FIG. 11.

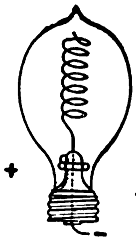


FIG. 12.

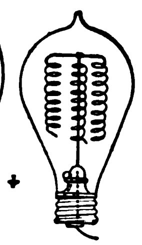


FIG. 13.

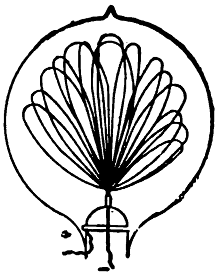


FIG. 14.

force surrounding a conductor, as displayed by the familiar arrangement of iron filings—indeed, it is a similar phenomenon—the molecules of the residual gas taking the place of the iron filings.

The next bulb (Fig. 7) is similar to the one last shown, but with one exception. The wire is not single throughout its entire length; for a space of about three inches at its center it separates into six strands, which thereby form a kind of cylindrical cage about one-half inch in diameter. In this case the entire bulb is not filled with a glow, but the interior of the cylinder forms a pencil of light quite dense, denoting that a new principle is brought into play. It is this—every current creates its own electrostatic field around its conductor, which, when immersed in a gas at the proper degree of rarefaction, causes it to give forth light, which is most dense in a comparatively small circle surrounding the conductor. (Fig. 8.)

When two wires, each having its field of force, are placed parallel to each other and about one-half inch apart, the density of the field between them will be doubled, and con-

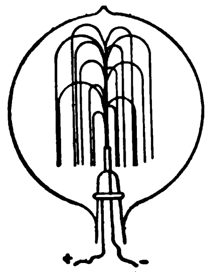


FIG. 15.

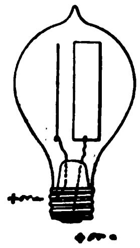


FIG. 16.

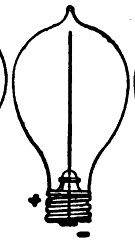


FIG. 17.

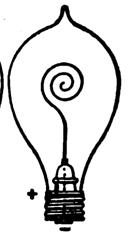


FIG. 18.

sequently the light in almost the same proportion. It will thus be clear that the pencil of light is due to the intersecting or overlapping of the fields of force of each of the six strands forming the cage. Upon this new principle many interesting lamps have been constructed, the problem being to get a maximum number of fields of force to intersect. Probably the best solution is in a cylinder made by spirally winding a wire, as in Fig. 9, causing its field to intersect in a manner that is almost ideal. This explanation may seem at variance with Faraday's famous experiment, proving that an electrostatic charge does not reside in the interior of the charged body. The vacuum may make the difference.

In this bulb (Fig. 10) there are two separate terminals projecting from the glass. When the spiral is connected to the negative pole of the vibrator, and the other terminal is made positive, the light is greatly increased. Such a lamp can be very conveniently made by using an incandescent lamp bulb, as in Fig. 11. The bit of platinum wire extending into the bulb and forming the positive pole, can be placed in any of the positions 1, 2, 3, 4, 5, without affecting the light in the spiral, but it is apt to become heated, and this is remedied by attaching to it a metal wire ring. (Fig. 12.)

In these lamps a large proportion of the light is confined within the spiral, and since volume is desirable, the idea of increasing the number of spirals suggests itself, as in Fig. 13. But the total volume of light emitted by four spirals is only equal to that of a single spiral lamp, that is, each pencil is but one-fourth as bright; hence, to bring them all to full brightness, the energy of the inductive current should be increased in proportion.

With the idea of obtaining from the entire bulb a uniform glow, the lamp shown in Fig. 14 was constructed. The "filament" consists of a great many complete loops of very fine aluminum wire. Fine wire was used, not only because of appearance and weight, but also for two other reasons: 1st, because a fine wire has about as large a field of force as a much larger wire; and, 2nd, because it does not obstruct the light so much, and at the same time is a minimum of metal within the vacuum. This is a matter of importance, as upon it largely depends the life of the lamp. A great many different conductors were used for the construction of these filaments, the main idea being to use that material which contained the least occluded gas, and would be disintegrated a minimum by the action of the current. Fig. 15 shows ordinary incandescent lamp filaments utilized in a glow lamp, but one leg only is cemented at the center of the bulb to the negative terminal, the other being free—a veritable fountain of filaments. A rather curious and not entirely explained phenomenon was noticed in this form of lamp, viz., the free ends of the filaments were apt to be violently agitated, and whenever they touched

the glass of the bulb, they heated up to a bright red throughout their entire length, producing a most brilliant combination glow and incandescent light. Many are the advantages of these lamps over those using fluorescent materials, as the sulphide of zinc or calcium. Sometimes when the exhaustion is carried a little too far, the vibrator current is unable to affect the lamps, but after they are held in contact with one pole of a large induction coil for a few moments, and then connected to the vibrator current, the trouble ceases.

In all of these forms of lamps it is very interesting to note that in order to get maximum light, the sub-divided terminal of the lamp must be so connected to the mains that it is negative. This is interesting to remember when the subject of lighting tubes is considered.

The class of lamps will now be considered where, instead of sub-dividing the lighting electrode into filaments, plane surfaces are used.

The bulb in Fig. 16 contains two pieces of sheet aluminum equal in size, set with their planes at right angles to each other, in order that a minimum of light may be interrupted from any point of view, and that the positive will act as a reflector to the negative. These pieces of aluminum must be carefully cleaned before being placed in the lamp, because any grease upon them will cause beautiful tufts of light all over their surfaces, instead of a glow filling the bulb, and the vacuum will soon be lost. Of course, in a lamp of this construction the poles can be changed with impunity, and if an alternating current be passed through the vibrator, both plates will give light, but the total amount will be the same as when direct current is used.

One of the many modifications of this form of lamp was to make the magnetic pole in the form of a small cylinder of aluminum gauze.

Many lamps were made on the principle of a spiral within a spiral, wound in the same or opposite directions, and also of using metallic coatings on the tube's interior and exterior, as well as using bulbs of all shapes and sizes. One important advantage to be noticed in all these forms of lamps is the total absence of the very objectionable striations, such as occur in the ordinary Geissler tube.

Fig. 17 is a very simple form of lamp—merely a single piece of straight carbon filament producing the light.

Fig. 18 is another of peculiar form—an unusual density of white light inside the convolutions of the spiral.

To determine whether there was any appreciable heat at the center of an intense pencil of light, a number of lamps were constructed in which various substances were placed at the point of greatest density of light, as in Fig. 19, but in no instance was the substance affected in any degree whatever.

Following out this idea a little further, there was inserted a small glass tube containing air properly rarefied in the center of a spiral, as in Fig. 20.

But the inside of the small tube remained dark; nevertheless, the glow outside of the spiral, dark space and other phenomena, even to the tufts of light between some of the convolutions of the spiral are the same as those in a similar lamp without a tube, inside the spiral.

Another lamp was then made the same as the last, except the tube inside the spiral has a platinum wire extending into it, which wire is electrically connected with the spiral (Fig. 21). Of course, the small tube was tried separately before being placed in the lamp bulb, and it filled with a white glow. But after the lamp was completed it refused to give any light; the glow outside the spiral, however, was the same as though there was no inner tube present.

Hoping to get a lamp with almost no metal in the light-producing vacuum, the lamp shown in Fig. 22 was constructed—the spiral is within a separate tube. When tried, a tuft of light appeared in the top and bottom of the small tube which was surrounded by a faint glow, the outlines of which are shown by the dotted line.

The next step was to do away with the inner vacuum and construct a bulb as shown in Fig. 23. When a spiral was inserted in the tube and connected to the negative pole, the positive being either 1 or 2, a dark space an eighth inch deep surrounds the tube, beyond which a faint pinkish glow appeared filling the bulb. The phenomenon known as "after-glow," which is sometimes noticed in evacuated bulbs after having been subjected to an electrostatic strain, I have been able to obtain, but very seldom. (Fig. 24.) However, this bulb could be picked up and carried around the room, but every time it was picked up after being laid down, a discharge resulted, which, being repeated three or four times, dissipated the glow entirely.

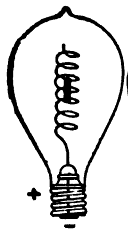


FIG. 19.

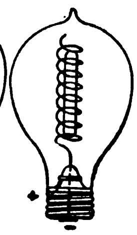


FIG. 20.

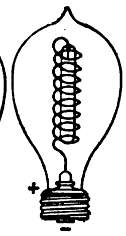


FIG. 21.

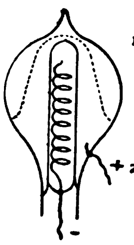


FIG. 22.

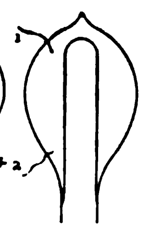


FIG. 23.

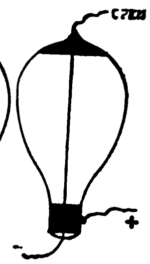


FIG. 24.

From a tube containing two parallel wires, shown in Fig. 25, but with a low degree of exhaustion, the glow was entirely absent, but instead brilliant, flaming yellow discharges completely filled the space between the wires, which was over half an inch wide and about two feet long.

At the beginning of the lecture your attention was called to the great similarity existing between the field of force of a "cold-light" giving conductor in a partial vacuum, and that of a conductor conveying a current in the open air. Care, however, should be taken to note that the light from the rarefied atmosphere is due to electrostatic and not electromagnetic phenomena.

For example, I have here a powerful electro-magnet which I connect directly across the lighting mains and, therefore, it is one at whose center or core the electro-magnetic field is very dense. When this tube, which has a diameter the same as that of the core of the magnet, has about half of its length passed through the center of the magnet, no light whatever results. If, however, but one terminal (the other being free) of this same magnet be connected to the vibrator, immediately the tube gives forth light.

Referring again to the subject of connections, Fig. 26 shows the light connected around the terminals of the magnet; it also can be connected with equal results around the break or spark gap as shown by the dotted lines. Your attention is called to the fact that lamps of this kind will operate equally well whether connected in multiple or in series, provided the area of the negative electrode is about the same in each; if not, that one in which the negative electrode is of greatest area will alone light up.

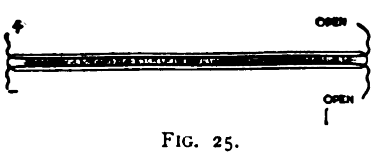


FIG. 25.

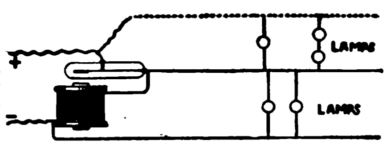


FIG. 26.

If a single bulb of small size be connected to a circuit of considerable induction, a well-defined discharge is liable to occur which will ruin the lamp.

In Fig. 27 an inductive resistance is distributed with each lamp, making the system of distribution self-regulating, that is, the turning on or off of lamps will not affect the brilliancy of those burning steadily.

Referring again to the diagram of circuits showing the system in its simplest form: If good results are to be obtained, the magnet must be designed and constructed with the greatest care. Its duties are twofold; first, to give the vibrator its mechanical motion, and second, to act as an inductive re-

sistance. The iron core must be proportioned to the conditions of the circuit. If there be too much or too little, the light suffers, but a certain amount of iron should remain, in order that the magnet have sufficient power to vibrate the armature. Similarly if there be too many or too few turns of wire on the magnet, the light is decreased. From this it is evident that vibrators of different rates will not be suitable to the same magnet. However, even when a vibrator is connected to a suitable magnet and circuit, and produces a good light, it can be further improved by "tuning the circuit," that is, altering its self-induction by varying the amount of iron in the magnet's core. It should also be stated that by this means a maximum light is obtained from a minimum current. In order that the time constant of the magnet be a minimum, and to insure rapid action, the magnets should be short and thick. Large induction coils cause the tubes or lamps to give forth but little light, while a small magnet, whose length of

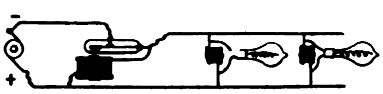


FIG. 27.

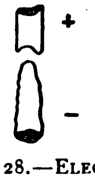
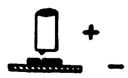


FIG. 28.—ELECTRIC LIGHT CARBON.



VIBRATOR CONTACT POINTS.

wire is not one-hundredth that of the induction coil, will cause the tubes and lamps to light up brilliantly.

It is interesting to note that with a comparatively few turns of wire a very small one-volt battery will give quite a strong glow. This glow can be intensified by using a secondary coil.

Although the various lamps that have been described are of great interest, nevertheless the very nature of lighting by luminescent gas is such that it is far more applicable to radiate from sources of considerable area than from units of light of small area. The best method of obtaining light from a large area is by the utilization of tubes of considerable length, instead of small bulbs. The light of these tubes should be entirely free from the very objectionable striations always present when interior electrodes are used; but these striations are entirely obviated by using exterior electrodes. They may be metal caps on the outside of the tube, or preferably merely coatings of metallic paint. Such tubes can be made up in almost any lengths, and can be bent into a great variety of forms, making them suitable for exquisite decorative effects.

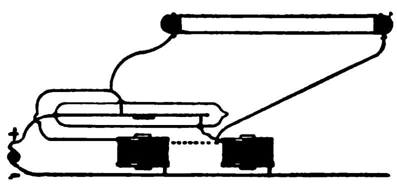


FIG. 29.

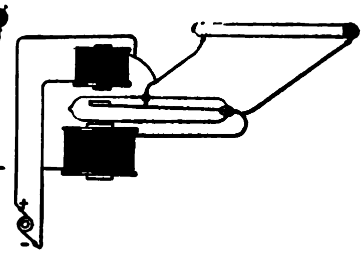


FIG. 30.

Under this head can be mentioned the fashioning of tubes in the form of letters, which may be used as electric signs.

Permit me to call your attention once more to the key of the whole system, viz., repeated interruptions of an electric current in a high vacuum.

The simplest method of accomplishing this object is to hermetically seal within a glass tube a vibrator of ordinary form, but its exact construction to give the best results has been a matter of tedious experimentation and study. The very slightest alteration in the dimensions of almost any of its parts—such as the length, width and thickness of the spring, or its method of mounting, or the position of the contact points, or the thickness or diameter of the amature, will cause it to be a very good or a very poor vibrator. Again, the operations of the glass-blower had to be watched most carefully. Only certain kinds of iron and steel were selected, to avoid occluded gases, and even then they must undergo a special treatment before being fit for use. The selection of suitable contact points has also been a large field for research. Nearly all known conductors have been tried, and many interesting facts have developed in this connection, not only so far as the direct action on the various metals in vacua and various gases is concerned (and this in several instances is the reverse of the phenomena noted in open air), but also with reference to the electro deposition or electrolytic action that takes place. For instance, as is well known, the positive electrode is the one which disintegrates most rapidly in the open air, and its apex is usually concave. This is probably best shown in the ordinary direct current arc lamps. If aluminum or any soft metal of comparatively low fusing point be used as contacts in a vibrator, after about a day's run, an examination shows that the shape and condition of the contacts are just the reverse of the way they appear after use in the open air. That is, the positive terminal looks like the negative, and the negative like the positive. (See Fig. 28.)

I have constructed several dozen distinct varieties or amplifi-

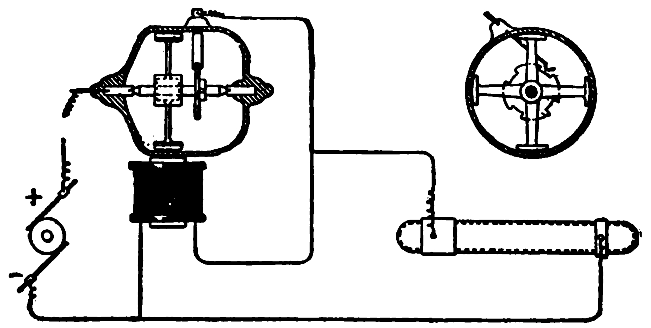


FIG. 31.

cations of the ordinary type of vibrator, such as multiple contacts, etc.

Fig. 29 shows one form, in which the object was to produce a larger number of breaks of the current per unit of time by providing two contacts, as shown. In some respects this scheme worked well, that is, the light was stronger than that produced by an ordinary vibrator with a single magnet, but the light was not steady, and when the connections were changed so that but one magnet was used, the light flickered still more. All the vibrators, so far considered, have had their springs so adjusted that the contacts remained normally closed. Fig. 30 shows a circuit using a vibrator normally open. The small magnet constantly closes the circuit and the large one opens it. This arrangement gave a good light. A number of ordinary vibrators have been operated, arranged with the magnet above the armature, so that gravity helps close the circuit. Of course, springs and armatures of scores of shapes and sizes, including gravity vibrators, have been tried, the principal object being to obtain a method for taking up the wear of the contact points; but the best solution of this problem lay in getting contact points that would not wear because of a more perfect vacuum.

Turning now from the mechanical construction of vacuum vibrators to consideration of their unique properties from a scientific standpoint. As stated before, roughly speaking, the prime object of making the break of the current in a vacuum is to produce an increased c. e. m. f. over that resulting from an airbreak. But I venture to say, few as yet realize the possibilities and the tremendous advantages involved in the separation of electrodes in high vacua at regular periods of time. It is indeed questionable whether the increased c. e. m. f. of the ether gap is responsible for the results. It is more probably due to the fact that the wave-lengths of the current resulting from an ether gap differ radically from any that have heretofore been known of. Recognition of the importance of this phenomenon led me to use the word "etheric" in connection with my system of tube lighting, because the light is directly dependent upon what I designate as the ether gap of the vacuum. Our best notion of the separate existence of the ether is formed by thinking of that which remains within a vacuum of the highest degree we can produce. It may have been noticed, that so far I have not used the word "phosphorescent." It is undoubtedly a misnomer as applied to tube lighting; but to make matters worse, there seems to be no word in existence exactly or even approximately suitable.

The word etheric is especially applicable to light produced by the ether gap. That incomparably better results should be obtained by using a vacuum as a dielectric seems to be in perfect accord with accepted theory which has largely been upheld by actual experimentation. For example, setting aside for the time being that part taken by the magnet, let us consider only the break—the spark.

First, what is required is a continuance of the rapid oscillations of an electric discharge, and I desire to show that this is accomplished by a vacuum vibrator in an ideal manner. One method of obtaining an oscillating discharge is to use a potential such that an air-gap of considerable width is bridged by the spark. But the manner in which such discharges succeed each other largely depends upon the irregular movement of the air within the gap.

This method is unsatisfactory for many other reasons, among them the very objectionable high tension required, but there remains the conductive method of causing a spark, exemplified in the ordinary vibrator and induction coil. Here the sparks in the primary circuit can be made to succeed each other quite rapidly, but the length of time required for each complete break is long. However, with the vacuum vibrator, a new and simple device, the conditions are different and so are the results. Here the dielectric is an exceedingly thin film of ether, which is capable of withstanding a great electrostatic strain, but when it does break down it does so very suddenly; that is, it may be considered a perfectly disruptive discharge, and therefore its single oscillations are very short; but as a whole they are long continued. This means that the frequency is high, and, according to Maxwell, very high frequency oscillations are probably identical with light.

The small magnet, being a circuit of induction, has its own natural period. But its period and moment of inertia will be less the less its capacity. That is, the smaller the magnet the smaller the period, or the higher its frequency can be.

But to have an intense light, there is required a high e. m. f. of self-induction. This the small magnet furnishes, because what is lost in self-induction by using a comparatively few turns of wire is more than made up by the suddenness of the discontinuance of current flow, and the fact that the high vacuum precludes the possibility of loss to the self-induction ordinarily due to the glow discharge which precedes the disruptive discharge in the air. The self-induction also depends on the amount of current flowing through a circuit when interrupted, and this the vibrator provides for, in that all the current which flows through the coil does not pass through an arc, but is transmitted over actual metal contacts. Also since these contacts are so very close, due to the thinness of the dielectric, the oscillatory discharges do not leave the metal and pass in objectionable minute streams through the vacuum. And the number of oscillations in the coil and the amount of light, depend in a measure on energy expended to overcome the resistance of the dielectric which is almost infinitely greater than that of air.

That the silent discharge prevents long continuance of oscillation is shown in the Hertz experiments, where the experiment fails unless the balls of the electrodes are kept polished. That the vacuum vibrator is nearly ideal is again shown in that these troubles are almost entirely eliminated. The ether is undoubtedly the ideal medium in which to disrupt an inductive circuit for conversion into light: since an exceedingly thin film (if this term may be so used) is a dielectric of such strength that a very small displacement results when it is disrupted, and the ether being the medium of minimum rigidity closes the "hole" the instant it is pierced. Such a medium for such a purpose is almost incomparable to air or oil, which becomes volatilized.

In order to get any oscillations, more sudden rushes of current must occur on discharging than on charging, and the more nearly these equal each other, the quicker the rushes will succeed each other. Now, in the case in question, when the tube circuit with its condenser coatings has a certain capacity, the self-induction of the magnet can be so varied that these two will always neutralize each other, and then the critical strain on the dielectric requires but little energy to cause a discharge, and the circuit being almost balanced, the surges follow each other in rapid succession through the tube. The surges continue for a longer time, since the energy of the discharge is not dissipated in heat on the air, but is conserved to be utilized in prolonging the existence of the oscillations. The use of this vibrator seems to afford the best means yet invented for impressing molecular disturbances in a tube. The longer the oscillations exist, the more nearly the mean oscillation approaches a constant period, and this period is practically governable as compared with that of currents due to magnetic blasts or heated air currents. The higher the frequency, the greater the mean free paths of the molecules, because a less number of molecules will then be required to cause a given number of collisions, and the less the number of impacts, the greater will be the light in proportion to the heat. But the frequency is dependent on the capacity of the condenser, which, in the case of the tube coatings, is very small.

When the self-induction and capacity are properly proportioned, and the rate of the vibrator is the same as the natural period of the coil, or any of its harmonics, then there is resonance, and the maximum amplitude of each impulse will be constant. In this case the current flow is at its maximum, but so also is the voltage at the ends of the tube, as well as the quantity of light produced with a minimum expenditure of energy. The velocity of the lines of force produced by an oscillatory discharge is supposed to be equal to that of light, but its wave-lengths are exceedingly greater. But this disparity is greatly reduced by the vacuum vibrator. This accounts for the intense light in the tube at comparatively low potentials, and indicates that nature's keyboard has been struck to the tune of 500 trillions of waves per second, and that this rate is maintained by the fundamental mechanical vibrations of the vibrator—about 100 per second—a most beautiful demonstration of nature's wonderful compass. But not only is more light produced by the vacuum vibrator than was heretofore obtainable, but there accompany it many other advantages of particular importance. Three of these can be mentioned: first, simplicity and greatly reduced cost of apparatus; second, the obviation of impracticable potential, and third, a very marked advance in economical production. The first heading, simplicity, has already been dwelt upon. Compare an inexpensive magnet, not as large as one's hand, and a vibrator the size of one's finger, attached to commercial currents, with apparatus costing thousands of dollars, consisting of a high speed alternating dynamo of many coils, oil transformers, disruptive discarges with magnetic blast, induction coils and condensers. The many seemingly unsurmountable difficulties encountered with this method are almost completely overcome by the simple expedient of the ether gap. Or, referring to ordinary induction coils, the vacuum break affords a means for obtaining from the few turns of comparatively coarse wire results not obtainable with mammoth and expensive coils, made of many miles of wire, and capable of creating enormous differences of potential.

The second heading is essentially a practical one. It has often been argued, to the detriment of tube lighting, that since it was admitted by its supporters that enormously high potentials were absolutely requisite to cause any appreciable amount of light, that therefore (and the argument was logical) the whole idea was extremely impracticable unless some new insulator be discovered that could cope with the high potentials, so difficult, dangerous and expensive of generation and manipulation, as to prohibit their use commercially. But with a current endowed with such properties as are given it by a vacuum tube vibrator, no new insulator is needed.

A light now results many times brighter than that formerly due to millions of volts, able to pierce several inches of hard rubber, or produce a spark many inches in length, from a current transmitted to the bulb or tube over ordinary flexible cord, and whose sparking distance is less than one-sixteenth of an inch. Neither can any shock be felt from such a current. Another example of the comparative ease with which this new current can be insulated is apparent in the magnets, wound in the ordinary manner, in striking contrast with the necessity for expensive and cumbersome oil transformers. In this light the exclusion of all gaseous matter does not seem to be a matter of such vital importance.

Closely allied with the subject of insulation is that of frequency. The higher the frequency, the lower the potential can be, not only with respect to light, but also to insulation, because irregularity in the rate of vibration puts the insulation to a severe test. However, the period of the vibrator is not rapid as compared to that of alternating dynamos, constructed to obtain similar lighting effects, but resulting in those of lesser degree. The alternations of such a machine are about 30,000 per second, which is further increased by a disruptive discharge coil. This was necessary to compensate for the long wave-lengths of the current. But since these lengths are so much shorter in the vacuum vibrator current, an initial frequency one-fifth as great without the use of additional coils and condensers produces far better results. But that an ordinarily constructed vibrator can attain a speed of 6,000 per minute may be questioned, when it is remembered that induction coil vibrators work at a rate of but little over 1,000. The difference lies in the fact that the vacuum vibrator has no air pressure to impede its movements, and also that a much shorter space of time is required for a single complete interruption, because the actual mechanical movement can be much less, yet cause a complete break, and another cycle has begun. The speed of the vibrators is ascertained in two ways: first, by comparing the musical note it produces with that of a pitch

pipe, and secondly, by a visual arrangement constructed and operated as follows:

A shaft, supporting a wheel with one spoke, is rotated rapidly by hand, a series of multiplying gears being used, so that when the hand makes one revolution per second, the spoke makes twenty. When this apparatus is operated in a room, lighted only by a single vacuum tube, the spoke will appear stationary in one, two or three positions, according to the rate of the vibrator. For example, if the spoke appears stationary in two positions, it indicates that it is illuminated twice in a single revolution, each image being due to a vibration.

Another subject, which has been a serious obstacle in former proposed systems, is that of impedance. The fact that the best conductors would cease to transmit current seemed a difficulty almost unsurmountable; yet it appears to be almost absent under these new conditions. For example, when a large coil is inserted in the high potential lead from the armature terminal to the tube, the effect on the light is surprisingly small. The result is the same, whether the wire be in the form of a magnet or in a long exposed line. But, nevertheless, on account of line losses, it is advantageous to prevent condenser action by using a wire as small as possible, yet able to stand the strain it is subjected to when its insulation is being placed upon it. Although the light produced by a single wire is quite good, it is decidedly advisable for best results to use a return wire, because the fundamental frequency is so low.

The third subject—economy—is so large, and of such importance that I deem it expedient to make it the subject of a future paper when accurate measurements have been made. Indeed, it is second only—but it is second—to the nucleus of the whole investigation, viz., getting light. The efficiency of the lighting tube is well established, due principally to the great amount of light accompanied by so little heat that it has by some been called "cold" light. The temperature of the gas within the tube varies with the density of the discharge from 12° to 132° C.; but even this is improved by the shorter wave-lengths. These figures are extremely low as compared with temperatures as high as 3,500° C., which must be reached by some substances in order that the light be white and the spectrum complete.

Owing to the peculiar characteristics of the current, the line losses are materially decreased, and the current flowing through the primary circuit is less when the tube is giving light than when it is disconnected. There are almost no losses for motive power to disrupt the current, for the magnet is its own motor. But the greatest loss has always been in the disruptive discharge—the spark. It is remarkable how easily several horse-power can be dissipated in the air through the intervention of a disruptive discharge. In this connection it should be borne in mind that magnetic blow-outs and air currents are merely heat dissipaters, and increase the loss, while these losses are entirely obviated by the vacuum vibrator. The current can perform a large amount of work on the air, unlimited in volume, with no apparent results; but when this volume is reduced to the campass of a small vibrator tube which remains perfectly cool in operation, does not the question of efficiency assume a different aspect?

Upon these reasons may be based logical conclusions, pointing to an enormous increase in efficiency over that of all other methods of obaining light in tubes.

The theory which has just been considered, of course, is not limited to a simple vibrator, but applies broadly to any method of interrupting the flow of current through a high vacuum. This can be accomplished in a great variety of ways, although as far as simplicity of apparatus is concerned, the regular spring vibrator, in connection with a single magnet, probably cannot be improved upon.

The first deviation, however, is to use a very small magnet to vibrate the armature, and to connect this in series with a larger one to furnish the induction. But in these cases the power of the operating magnet depends on the current passing over the contact points; hence to make the light which is dependent on the contact points perfectly positive, the power should not be dependent upon them, and separate circuits suggest themselves—that is, cause an intermittent current to flow through the power magnet that does not flow through the contact points of the vibrator, which have in circuit with them the inductive magnet. Or the electrodes can be separated by mechanical jarring instead of magnetic power acting through the glass.

If an ordinarily constructed vibrator be attached to any form of rapidly oscillating mechanism, the contacts within will be opened and closed rapidly. But in order that the light be steady, the movements of the vibrator armature must be in step with the movements of its mechanical support. This is best accomplished by having the center of the oscillation of the vibrating armature coincident with that of its oscillating support.

It is plain that it is unnecessary that the current be interrupted by a reciprocal motion only; a rotary motion is also applicable.

Fig. 31 shows a form somewhat analogous in operation to the simplest vibrator, except that the rotary momentum of the armature takes the place of a spring, and the break-wheel which furnishes the light also acts as a commutator to the simple form of motor.

Another way of obtaining a rotary motion within a vacuum is to attach a pendant weight to a ratchet wheel, free to rotate upon a shaft attached to which is the brush. Since the shaft is rigidly sealed into the glass, it is evident that when the bulb be rotated by a motor, the brush will revolve around the

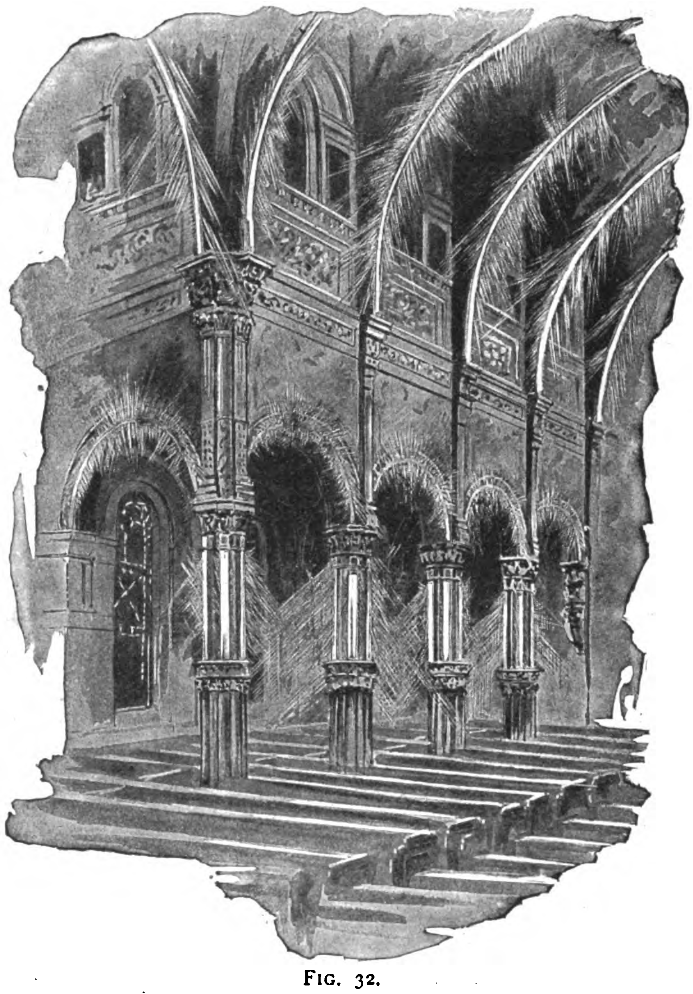


FIG. 32.

break wheel. The fault with the device is that the pendulum will have a vibration of its own, causing the light to waver.

In order that the make-and-break devices dependent upon a rotary motion be absolutely positive, a rotating magnetic field has been utilized. Since the experimental side of these investigations has extended over but a few months, it is at present difficult to say upon which of these methods, developed, the system will take final form.

Returning once more to the subject of the light in the tube. It is interesting to note, that although the most intense light is produced when both of the ends of the tube are connected to the electrodes, it is well known that light also results when the tube is merely placed near an electrode without actual contact. This phenomenon is known as lighting by induction.

If an inductive circuit, sufficiently powerful to brilliantly illuminate a tube four feet long, be transferred to one two feet long, there will appear at the center of this small tube a very intense thread of silvery white light, which undulates as if it were a material substance. It is interesting to contrast the color of the light of these tubes with that of an incandescent lamp. The reddish and wasteful glare of the latter, indicating heat waves, and the pure daylight white of the former, are immediately apparent. It is this difference in color that makes an efficiency calculation so difficult. It is very easy to ask the question: How many watts per candle power? But in most instances it indicates a lack of information on the part of the questioner. The question should be: How many watts per

amount of light equivalent to one candle-power? But even this is not perfectly correct, because it is wellnigh impossible to compare accurately lights of a different color and power of diffusion. When the use the light is to be put to is stated, the problem is much more simple. For instance, if it is to be used to read by, the range of legibility can be made the basis of comparison between the true glow lamp and the candle. This most popular form of illumination, from the twelfth to the beginning of this century, is still the standard of illumination, although it is probable it will soon be deprived of this honor. I may be pardoned for calling your attention to the remarkable intensity of the light in these tubes, in connection with the statements repeatedly made by eminent scientists, that such intensity was an impossibility, and that efforts in this direction were comparable to those wasted on perpetual motion.

The very nature of the light, if it is to be counterpart of the ideal daylight, is such that when a square inch of the surface of the tube emits as much light as that thrown into a room through an aperture one inch square, the want is satisfied. Then the desired illumination can be reached by multiplying the area and length of the tubes, and distributing them in the most advantageous manner, that is, so that the light will fall from all directions. When a considerable area is to be lighted, the most efficient light is the one that is most equally distributed. However, there will always be a demand for units of light. Even this can be satisfied by using a tube of small caliber. This lamp is made by winding a small tube in the form of a spiral, its ends, to which the wires are attached, terminating in oblong bulbs three or four times the diameter of the small tube.

I have previously stated that the alphabet has been constructed of tubes of light. Here are the initials of the body I have the honor to address, A. I. E. E., in letters twelve inches high. The delicate shades of these letters cannot fail to elicit admiration from all who love the beautiful.

The principle of breaking a circuit in a vacuum has many applications to a variety of uses. Among them may be mentioned, advertising signs, decorative electric lighting, electrotherapy, philosophical apparatus, theatrical effects, in the manufacture of ozone, in the kinetoscope, etc., etc.

But the greatest field will ultimately be that of general illumination. You have noticed the tubes extending around this hall. Undoubtedly this is the first time that lighting by tubes has been attempted on so large a scale. You will note the almost entire absence of shadows.

Fig. 32 illustrates what we are coming to in the way of church lighting. For some time past everything has pointed to the general adoption sooner or later of some such form of illumination, and since volumes of light can now be produced, and of commercial intensity, does it not indicate that already this light is a matter for serious practical consideration, and no longer a pyrotechnic curiosity?

But the only way in which one can form a comprehensive or appreciative idea of what advance in this line of work really means, is to compare the situation of to-day with that, not of a hundred years ago only, but with that of only twelve months ago, and note the contrast.

ELECTRIC LIGHTING CONTRACTS IN BROOKLYN.

The Brooklyn aldermen approved of these public electric lighting contracts:

Edison Electric Light Company, 35 cents per light of 1,200 candle power a night, and 17½ cents for lights of 600 candle power.

Municipal Electric Light Company, arc lights of 1,200 candle power 34 cents, and for incandescent lights 16 cents per 1,000 watts metric measure.

Citizens' Electric Light Company, for lighting public buildings, 2.2 cents per lamp hour. For street lighting, 35 cents per light, 1,200 candle power.

There are now 2,250 lights in use, and they will soon be increased by a thousand. It is claimed that the city will save $35,000 by this year's contracts.

THE ELECTRIC CIGAR LIGHTING AND ADVERTISING COMPANY, of St. Louis, has been formed by M. J. Stern, P. Werner, and C. B. McCormack, with a capital stock of $20,000.

THE BLOCK LIGHTING AND POWER COMPANY, with offices at the Grand Hotel, proposes to increase its capital stock from $50,000 to $100,000.

THE OHIO STATE SENATE has passed the Jones bill inflicting the electrical method of punishment in death sentences, and it is expected that the House will concur.

KNOXVILLE, TENN.—The new electric light plant about to be installed by the Brookside Cotton Mills, Knoxville, Tenn., will consist of General Electric Company dynamo and a Ball engine of the Ball Engine Company (Erie, Pa.) manufacture.

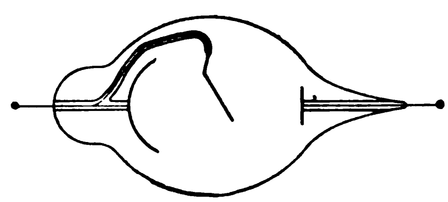
FURTHER PROGRESS IN RADIOGRAPHY.[1]

BY DR. OLIVER J. LODGE.

I HAVE been several times forced to surmise that just as the original Lenard rays are easily stopped by a few inches of air and have feeble penetrating power, so Röntgen rays may be of two or more kinds, perhaps differing in something of the fashion that violet light differs from red; and that, whereas close to the source we get Röntgen and Lenard rays mixed, and a little further off Röntgen rays only, i. e., those which discriminate most clearly and throw therefore the most instructive shadows, so after great obstruction, like a human body, only the most penetrating quality of ray gets through. And under these circumstances the interposition of the palm of one's hand scarcely adds to the shadow, nor do the bones of the palm make their appearance in so prominent a manner as one might expect from the general brightness. Against this, however, is to be recorded the fact that I have taken a photograph of a spine to discover the nature of the damage to a vertebra in a patient, and the details of the processes of the vertebræ.

When the cathode rays do not first strike the glass, but first strike a piece of metal inclosed in the bulb, then its behavior depends largely on what it is connected to. My experiments on this point are not complete, but this much is certain, that if the bombarded piece of metal is attached to the cathode, so that it is unable to receive any electrical charges from the cathode stream, then it either declines to act as a source of rays at all, or else emits a radiation of the most feeble kind, which can without difficulty be attributed to a secondary cause. But on the other hand, if the bombarded disc be connected to the anode, so as to be able to receive the negative charges of the cathode stream, then it acts as a most vigorous source. In a low state of vacuum it will indeed get hot and radiate light, but in a high vacuum every part of the bulb keeps perfectly cool, and the whole energy supplied seems to pass off in X-rays.

The following experiment is worth quoting at greater length: A bulb like this, with concave electrode, having at its



center a rather thick aluminum plate connected to it metallicly (wires protected by glass), and beyond in its shadow the other electrode, was excited either with the cup as cathode or with the cup as anode, and pinhole photographs were taken simultaneously from various points of view, and at measured distances. A glass plate was subsequently put in the position of each of the sensitive plates, and the appearance of the tube as seen through the "pinholes" (which were one-quarter inch diameter), by an eye roving about, were drawn in ink upon the glass. The eye-picture thus obtained was afterward compared with the developed images, and the sources of the radiation thus clearly observed.

When the small flat disc was cathode, every part of the complicated anode appeared strongly and quickly on the plate, especially the tilted and first bombarded portion on a plate placed above the tube. The cathode disc itself did not show at all. On a plate placed below the bulb the anode cup appeared strong, but the tilted disc did not appear. On the other hand it threw a sharp faint shadow of the hole, showing that its focus spot acted as a feeble point source, by reason of a few rays reflected back onto it from the cup.

When the current was reversed, the small disc anode showed faintly, being excited by rays which had penetrated the interposed tilted disc, but again the cathode hardly showed at all, not even the tilted portion on a plate placed below the bulb. By giving a very long exposure (two hours) some impression was obtained, about equal to that from the shaded anode disc; but, of course, if the tilted plate had been under these circumstance an anode, it is well known that a few minutes would have sufficed to show it strong upon the plate beneath.

[1] Abstract from the London "Electrician."

FALK'S X-RAY EXPERIMENTS.

We have received from Mr. Hilbert L. Falk, of New Orleans, a number of remarkable photographs taken by means of the Röntgen rays and showing with apparent clearness the muscular and other soft tissues of the body. Mr.

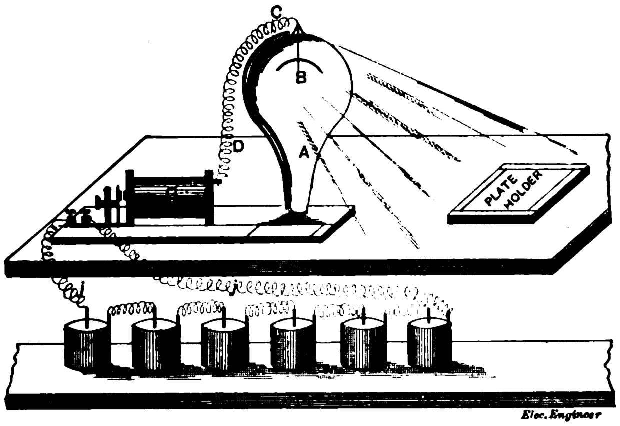


FIG. 1.—FALK'S ARRANGEMENT FOR TAKING X-RAY PHOTOGRAPHS.

Falk's X-ray photos are taken by connecting only the positive terminal of the coil to the tube. He employs in addition an aluminum reflector, C, as shown in Fig. 1

The engraving, Fig. 2, is reproduced from an X-ray photograph of the human brain taken with a photographic plate especially prepared, and it is principally due to the nature of the photographic film that the results are obtained. What this special film is Mr. Falk does not desire to disclose for the present.

Between the head of the subject to be photographed and the

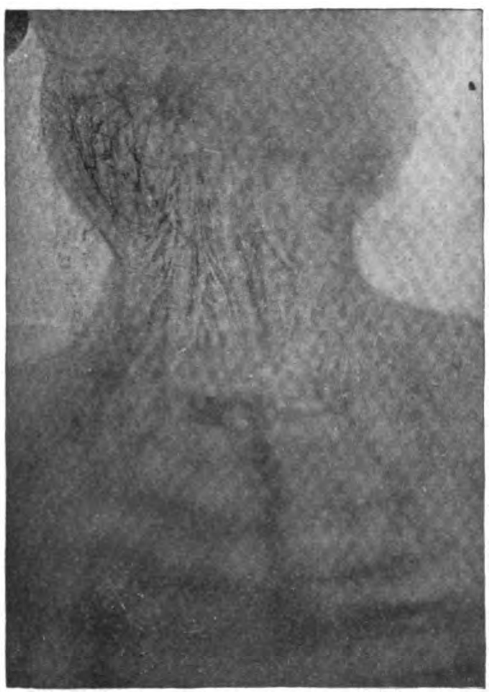


FIG. 3.—X-RAY PHOTOGRAPH OF THE MUSCULAR AND VASCULAR SYSTEM OF THE NECK.

Crookes tube there were placed a sheet of tinfoil and a number of wires attached to the foil at different points. The other ends of these wires were all joined to the negative terminal of the induction coil. A large sheet of bright tin was placed about two feet back of the subject's head. An exposure of seven minutes was required. The dark spot marked X marks the point where the subject photographed was struck by a brick several years ago.

Fig. 3 shows the head and neck, the photograph from which the engraving was made being a photographic reduction from the original full size plate.

We give the above results for what they are worth, and regret that Mr. Falk is not prepared to enlighten our readers

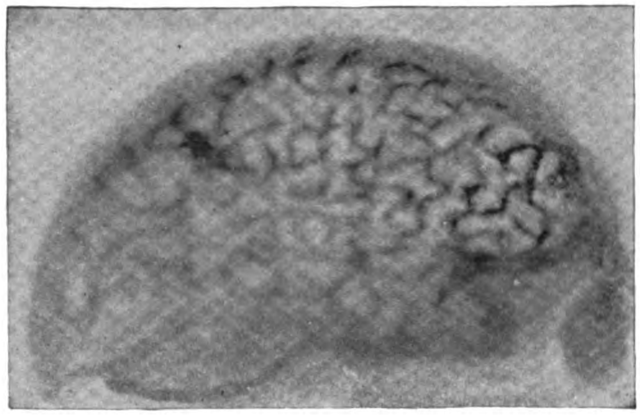


FIG. 2.—AN X-RAY PHOTOGRAPH OF THE HUMAN BRAIN.

on the nature of his plates and screens, among which he uses silicate of soda and tinfoil.

THE DIFFUSION OF ROENTGEN RAYS.

Elihu Thomson

I SENT you some time ago a short article on the diffusion of Röntgen rays, and at the time I was not aware that any work of a similar nature had been done, though, it is true, that certain suggestions had been made as to the turbidity of media by, I think, Lenard and Prof. Röntgen.

I find that Dr. M. I. Pupin has in "Science" of the issue of April 10, given an account of his investigations on the diffusion of Röntgen rays which accords with my results in most important particulars. I was not aware that he had done the experimental work which is described in the article and am now pleased to note that he has gone into the subject very carefully and very thoroughly—in fact, more thoroughly than my time permitted my doing.

These observations on the diffusion of Röntgen rays show that sharp, clear-cut shadows of bones, or objects, imbedded in a considerable depth of flesh cannot be expected where the rays have to traverse a considerable depth of flesh after passing the imbedded bone or object, and that blurring or diffusion which wipes out the image may be so great as to make it very indistinct if large masses of semi-transparent material are between the plate or screen and the object the image of which is to be depicted. It is easy, also, for the experimenter to be misled into thinking that the diffused rays back of the bone or object really have come through that object, when in reality the presence of the Röntgen rays back of the solid object which casts a dense shadow is due to nothing more than the diffusion.

I regret to hear that Dr. Pupin's valuable work in this direction has been interrupted by a serious illness.

LETTERS TO THE EDITOR.

SILICON CARBIDE OR "CARBORUNDUM."

Would it not increase the value of the information contained in Mr. Edison's communication, in your issue of the 15th inst., to explain that the "Silicon Carbide" referred to is the carborundum manufactured at Niagara Falls. I have no doubt many of your readers will be interested in having this explained, as some may wish to experiment, and might fail to recognize the material by its chemical name.

E. G. ACHESON.

Carborundum Company, Monongahela, Pa., April 17, 1896.

THE

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CONTENTS.

VACUUM TUBE LIGHTING.

TO those who follow closely the work of inventors and enterprising manufacturers it must have been long since apparent that a constant struggle is going on to provide, at least for interior illumination, a type of lamp having a higher "efficiency" than the incandescent lamp. The improvements which have resulted from this struggle are apparent in the higher efficiency lamps on the market, albeit the life of these lamps may be somewhat shorter than that of their predecessors. It is this factor of life, indeed, to which, in reality, may be traced the quest for that "light without heat" which the writers of magazine articles have for the last ten years or more held up before their readers as one of the three or four great problems now confronting scientists and inventors. If only we could coax from the glowworm its secret we would be at once freed forever from that fearful waste of energy which has always attached to artificial illumination of whatever nature. But unfortunately, the glowworm is uncommunicative, and so we have had to be content with imitating its light as closely as our meager means have permitted. In these imitative efforts the vacuum tube has, of course, played a most important rôle. It is not our purpose here to recall the history of the art, but it will suffice to say that Mr. Tesla's memorable experiments accompanying his Columbia College lecture in 1891, and his subsequent communications and lectures abroad, served, perhaps, more than any other factor in fixing the attention once more upon the great problem before electricians. The means employed by Mr. Tesla to accomplish his results were brilliant in conception, and it is, therefore, all the more to be regretted that that great inventor has allowed his attention to be diverted by other matters, such as his oscillator, which have necessarily stood in the way of working out his vacuum tube light on a commercial scale.

But, in the mean time, others have taken up the subject with no less enthusiasm, though employing means differing radically from those heretofore adopted to accomplish the desired end. Among these is Mr. D. McFarlan Moore, whose persistent work has been steadily kept before our readers and who, last week, read a paper on his most recent progress before the American Institute of Electrical Engineers. The announcement that Mr. Moore was to light the auditorium with vacuum tubes was well calculated to bring out a large attendance. There was an intensely interested crowd of members, who, for nearly three hours, were kept in close attention by the description of a most laborious and painstaking series of experiments, many of which were illustrated by apparatus shown in operation on the lecture platform. Mr. Moore left to the very end the lighting up of the hall by means of his vacuum tube system, and, considering the difficulties he had to contend with, the results shown were extraordinary. Indeed, we have no hesitation in saying that no such results in vacuum tube lighting as shown last Wednesday night have ever been even approached, and had it not been for the ill-hap of an assistant, who switched out two coils of a motor-starting box instead of seven, the effect would have been better still. As it was, however, Mr. Moore may claim the distinction of having for the first time, so far as we are aware, lit up by vacuum tubes an auditorium holding 150 persons sufficiently to enable every one to be clearly seen and ordinary print to be read anywhere with ease. We may add that on an evening subsequent to the lecture the apparatus was operated to far better advantage, and that the room was photographed by the vacuum tube light in a 30-second exposure.

Many will regret that Mr. Moore did not embody in his paper some information as to the energy consumed by his vacuum tubes, since, judging from the wording of a passage in his paper, he appeared to consider this item one of secondary importance. Fortunately, we are enabled to supply this deficiency in Mr. Moore's paper, and to announce the fact that Mr. Moore's twenty-seven vacuum tubes practically

absorbed no more energy than the twenty-five incandescent lamps with which the Institute auditorium is regularly lighted!

To be exact, each of the twenty-seven tubes, which were 7 ft. 6 ins. long, by 1¾ ins. in diameter, took one-eighth of an ampere at 450 volts, as measured by recently standardized Weston instruments; that is, a fraction over 56 watts per tube, or a total of two horse-power for the entire number!

We abhor sensationalism, but cannot resist the expression of our belief that this result, once its import is fully grasped, will influence powerfully future work in this direction. Mr. Moore's system of vacuum tube lighting is still open to improvements in some of its details, but enough has been shown to demonstrate its immediate utility for a number of useful commercial purposes. It can only be a question of time when all its features—including the character of the light, which to some appears too garish, like that of a Welsbach burner—will have been brought into conformity with the demands of the public. As to its economy, that point seems to be well disposed of, so that it remains now only to reduce the apparatus and adapt the light to a commercial basis, and with the simplicity of the apparatus employed this ought to be accomplished in a short space of time. If vacuum tube lighting be not the direction to work in, we would like to be informed what is.

GENERAL ELECTRIC OUTLOOK.

Last week The Electrical Engineer was able by its enterprise to present its readers with the General Electric Company's annual report, although several of its esteemed contemporaries had never a word about it and others had but a brief reference. This report is always one of the leading events of the year, and worthy, therefore, of the effort we made to put it promptly before the electrical public.

As we took occasion to note last week, the General Electric Company would appear on its own showing to be worth about forty cents on the dollar. A concern which with liabilities of some $45,000,000 writes off $13,917,000 to profit and loss, would appear to be in need of reorganization of some kind, perhaps in personnel, but certainly in its financial basis. If the company were alone in the field or enjoyed monopolies, it might recover from such losses, as other concerns often do, but we do not believe that a single well informed person in the electrical field expects to see that done. On the contrary, with the rising tide of competition sweeping away much of its business, and with the tendency to specialization making many of its 9,000 products rapidly out of date or second class, it would seem that, in spite of the financial skill of a high order that the company evidently has at command, it must submit to the impairment of its capital as a permanent condition.

Besides the fact that the huge capital is based on an assumed monopoly which never did and never will exist, it is to be recognized as one of the conditions of the times, that a large number of the local companies are quickly drifting out of touch and sympathy with the company. They complain of bad faith, ill treatment, and high prices, and are beginning to buy freely outside the company's factories, or to be more or less directly interested in rival undertakings. In 1894, the attitude of the old Edison local companies was very warlike and threatening; and if there has been any change since then except for the worse, we have failed to note it in our inquires and observations.

Mr. Coffin's report, as President, notes the "patent deal" with the Westinghouse Company. We fear that Mr. Coffin is not telling all the truth. It doesn't make much difference to anybody what the deal is, but when such papers as the "Philadelphia Record" go so far as to talk of the "business pooling," it is clear that the real facts are leaking out. Our own impression is that a straight out pooling on business exists, and that the percentage alleged to apply to the patents really applies to the amount of sales. In fact, we do not see how anybody but a subtle mathematician, crossbred between a Steinmetz and a Pupin, could work out a "patent" percentage; whereas a rate of division on sales, with sliding give and take, is the easiest thing in the world to work out and to play on the stock market. If our surmise be correct, then Mr. Westinghouse has got the better of his dear friend Mr. Coffin, to a most appreciable degree. But then Mr. Westinghouse as a lamb was never greatly inclined to lie down with the lion—on the inside of that noble animal.

THE X-RAY SOUND WAVE THEORY.

THE theory put forward by Mr. Edison to account for the Röntgen ray phenomenon, namely, that it is a high-pitch sound wave, has not met with general acceptance, and this is scarcely to be wondered at, considering the strong preconceived notions of physicists on the nature of cathode rays and their effects. But in looking over the phenomena recently brought to light by many experimenters in connection with the Röntgen ray, it strikes us that we may have to considerably alter our views regarding the transmission of sound waves through a vacuum. It is an accepted fact in physics that sound will not travel through a vacuum, and when we have reached the highest attainable exhaustion, light then passes through, transmitted by the ether. According to mathematical deductions from the kinetic theory of gases, Schuster's accepted explanation of the working of the Crookes radiometer and the condensation of carbonic acid gas upon glass, as shown by Bottomley, J. J. Thomson, and Bunsen, together with the known presence of mercury vapor, our highest attainable vacuum still contains billions of molecules, and it is still conceivable that if a sound wave in air of small wave length strike the outside of the glass tube, it would be transmitted across the vacuous space not in the manner usually assumed—by rarefaction and condensation—but by bombardment or impact of the residual molecules thrown by the elastic wave in the glass across the bulb. Hence the fact that a vacuum does not stop the X-ray except, as we understand, to weaken it; but, Mr. Edison contends, this cannot be used as a positive proof that the ray is not a sound wave, and he is still searching for facts in further confirmation of his theory.

We note from a cable dispatch in the New York "Sun" that Professor Röntgen has published several important new discoveries connected with the X-rays. He has ascertained that all solid bodies can generate them under the influence of cathode rays, the only difference being as regards intensity. The most intense are produced by platina. He further says that the insertion of the Tesla spark gap break apparatus between the ray-producing apparatus and the Ruhmkorff apparatus is highly advantageous. He has made several experiments which confirm his observation that X-rays can discharge electric bodies, and that air illuminated by the rays can do the same. He further declares that electric bodies surrounded not by air, but by hydrogen or by highly rarefied air, are also discharged by the rays, though much more slowly.

THE ELECTRICAL EXPOSITION.

IT is now officially announced that the National Electrical Exposition will be opened with all appropriate formalities by Governor Levi P. Morton, of New York, at 8 p. m. on May 4. The occasion is likely to be one of great brilliance and interest, and we understand that every effort will be made to render it memorable. The last national electrical exposition, that at Philadelphia in 1884, was opened by Governor Robert Pattison, of Pennsylvania.

The pressure for space at the exposition has been so great that the exhibits have now overflowed to the third floor, of which a large part will be occupied as an annex by the Patent Office exhibit, the Edison Fluoroscope exhibit, and the Practical Electrical Laboratory, together with a number of commercial exhibitors.

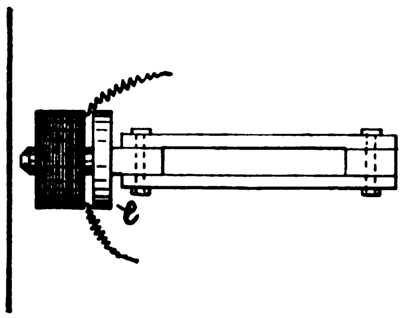
TELEPHONY AND TELEGRAPHY.

FIELD'S LONG DISTANCE RECEIVING TELEPHONE.

HERETOFORE the improvements in long distance telephones have been confined almost exclusively to the transmitter and the line, but that clever and indefatigable inventor, Mr. Stephen D. Field, has recently pointed out an improvement in the receiving telephone which he claims to be of special benefit in long distance work.

The improvement consists in encircling the core or pole-piece of the telephone magnet by a closed conducting circuit, such as a thick ring or disc of copper or other non-magnetic metal as shown in the accompanying engraving at e. When a receiving telephone thus equipped is placed in a circuit near a powerful transmitting telephone in the same circuit, the side tone in the receiving instrument is observed to be of much less volume than in a similar telephone devoid of the closed auxiliary circuit, while if it be placed at a distant station of the same telephone circuit its efficiency in receiving transmitted speech is found practically as high as that of the ordinary telephone, and reproduced sounds are characterized by improved clearness of articulation.

Mr. Field offers the following tentative explanation to account for the peculiar action above described:



FIELD'S TELEPHONE TRANSMITTER.

As is well known, the current flowing in a telephone circuit at any point is of less volume as the point is more distant in the circuit from the transmitting instrument. This is especially true of circuits of high capacity, such as are the usual long line circuits. The phenomenon results from the absorption of the energy of the current in the insulating medium, so to speak. Hence the pulsations of current, particularly the slow pulsations corresponding to the fundamental tones of the voice in the circuit near the transmitter, are of much greater volume than the corresponding undulations at the receiving instrument of the distant station. Now when such heavy current pulsations traverse the magnet coil of the telephone they tend to induce profound magnetic disturbances in the iron of the magnet core; but such large changes are reduced by the damping or demagnetizing effect of currents induced thereby in the copper ring. On the other hand, suddenly and feebly undulating currents produce only slight and superficial disturbances in the pole-piece or core, which affect the diaphragm, but do not affect the copper ring, and are not damped thereby.

In transmission through the line circuit the rapid harmonic waves are more largely absorbed than the slower waves, whereby the consonance or correspondence between the original acoustic vibrations and the telephone current is impaired, and the timbre is altered; but in the reconversion of the telephonic current into acoustic vibrations in the new Field receiving telephone the fundamental electric pulsations are reduced, leaving the harmonic vibrations accentuated in relation to them, and to some extent restoring the original timbre. In short, the reproduction of the transmitted sound in its original quality is attained by two complementary processes of degradation of the vibrations.

BELLEVILLE, ILL.—The Kurtz National Telephone Company, of this city, has been formed with a capital stock of $20,000 to put in 300 telephones in business offices and 200 in residences. A liberal franchise has been granted to W. J. Kurtz, who formed the Decatur (Ill.) and St. Joseph Companies of 600 telephones each, and who now has his headquarters at the National Hotel, Belleville.

ON TELEPHONIC DISTURBANCES CAUSED BY HIGH-VOLTAGE CURRENTS.[1]—III.

BY DR. V. WIETLISBACH.

(Concluded.)

A further means of counteracting the spreading of the high-voltage current through earth consists in insulated cables laid underground from the generator to the points of greatest load of the tramway system, and at these points connected with the rails. By this means, high differences of potential between the different sections of the tramway system are avoided. Of course, the rail joints must be such as to ensure adequate conductivity; this can be enhanced by bare copper wire. With the aid of these various expedients, it is possible to keep down the leakage of current from the rails within certain limits, while, in specially difficult or serious cases, there always remains the remedy of replacing the earth return of the telephone lines by a complete metallic circuit.

Far more difficult is it to deal with the effects of induction, which latter, as already stated, is due to the continuous current, supplied from the generator becoming an undulating one, owing to the motion of the cars. Two causes suggest themselves as operating to bring about this effect. One is the motor itself, during rotation of which successive pairs of commutator segments, connected to corresponding armature coils, are alternately short-circuited under the brushes. The effect produced thereby may be somewhat mitigated by increasing the number of commutator segments which will also result in raising the noise to a higher pitch. The other cause will be found on the line itself, i. e., at the point of contact of the conductor with the collector, in this case the trolley wheel. This latter is fixed to an elastic rod which, upon the car being started, assumes a vibratory motion. Moreover, the contact wire, which in this respect behaves like a drawn cord, also experiences considerable vibrations as the trolley wheel runs along its surface. Consequently, and as in the similar case of a microphone, the resistance at the point of contact undergoes a change, and the result is an undulating current. In fact, the inductive noises separately produced by the two causes referred to, i. e., the motor and the trolley wheel, can be distinguished side by side in the telephone apparatus.

It is curious to note that the noises produced by different electric tramways of similar construction vary considerably in degree, and, further, that these noises are, as a rule, comparatively slight when the tramway has just been opened for traffic, and that only in the space of a few weeks do they attain an intensity which renders telephonic communication difficult. It is not clear how this gradual change takes place, if at all, in the motors; on the other hand, it may conceivably be due to the contact wire, which gradually becomes loosened at the insulators, while the supports, too, attain greater play and move more freely in consequence of the constant vibrations to which they are subjected.

That the mode of contact is also a factor in the phenomenon referred to appears probable from the further fact that the increasing intensity of the noise is observed chiefly on tramways where the current is collected from the contact wire by trolley wheels, whereas tramways using slide contact-bars or shoes experience that phenomenon in a far less degree. An important difference between the two systems consists in the circumstance that where the trolley wheel is used, the contact wire must be suspended as exactly as possible over the axis of the tramway, in order to prevent the trolley wheel jumping off the wire, whereas in the case of the slide-bar or shoe, so high a degree of accuracy is unnecessary, and the contact wire therefore requires fewer points of suspension, nor need it be drawn so tight. In the former case the elastic vibrations of the contact wire are of high frequency, and correspond to the acoustic waves perceived by the ear. In the latter case, on the other hand, the vibrations are of so low a frequency, i. e., so slow, that they fall outside the range of perceptibility of the ear. The aërial crossings and bifurcations of trolley tramways involve much greater difficulty of construction than those of tramways with slide contact, and when the electrical connection or the insulation at those points is defective, such defects will likewise aid in aggravating the phenomenon referred to.

In some quarters great weight is further attached to the lubrication of the contact surface. Be that as it may, the fact is attested and confirmed that some electric tramways produce in telephone lines only slight or moderate disturbances which can easily be obviated or neutralized, whilst other electric tramways cause telephonic disturbances of so marked or violent a character that even mere crossings of telephone lines having metallic return and possessing a somewhat high capacity suffice to render telephonic communication extremely difficult.

In such cases, the only remedy is to bury the telephone lines which are in proximity to the tramway under ground. Having regard to the considerable expenditure which the laying of such cables involves, it would certainly be worth while to further investigate the causes of those telephonic disturbances which may presumably be obviated by very simple means. As regards cost of construction, electric tramways which do not cause telephonic disturbances are in no way more complicated or more costly than tramways which do produce the noises referred to. It is even reasonable to presume that the wear and cost of maintenance are less in the former than in the latter case.

Electric tramways having underground conductors will, presumably, not give rise to telephonic disturbances. On the other hand, it will not be out of place to mention one electric tramway which is now in course of construction, and which it is proposed to work with three-phase current, two of the conductors being constituted by two overhead wires, and the third conductor by the rails. In this case, it is no longer a question of an undulating current whose oscillations might possibly be mitigated by electro-mechanical means, but of a high-tension alternating current, which to the telephone lines simply means unconditional surrender. It is obvious that here the low-voltage, i. e., the telephone, lines will have to give up their earth return over a wide range. But the high-tension system referred to claims to be paramount even in the aërial space. Double telephone wires of low capacity are practicable only for parallel lengths of a few hundred metres; for as soon as the capacity increases, the amount of the intrusive high-tension current exceeds that of the telephone working current. Under these circumstances, the only means of rendering the regular working of the telephone service possible is to bury all the aërial telephone wires underground; only this is no longer a case of equable compromise, but of being overcome by brute force.

In dealing with telephonic disturbances, it must be borne in mind that the radius of telephonic communication from a given center increases, in accordance with the demand of the public, from year to year. Originally it extended to a few hundred metres, then to several kilometres, whilst the radius is at present several hundred, and will soon be several thousand kilometres. With this rapid growth the strain on telephone apparatus and installations increases also as a whole, and it is no easy task to maintain them always in the required degree of efficiency. If, therefore, the working of the telephone is not to be in a great measure restricted and its efficiency impaired by the disturbances caused by high-voltage currents, these disturbances cannot be permitted to make themselves felt in telephones more than other accidental sounds or noises governed by meteorological and other conditions.

A high-voltage installation may produce a noise which per se has no disturbing effect on telephones, but the same telephone line may, in a length of several hundred kilometres, come in collision with 20 or more high-voltage installations, and the sum of all the disturbances produced by those installations collectively will suffice to give a death blow to the telephone.

There is, therefore, a wide and fundamental difference between a short telephone line which only serves to connect two local points (e. g., an electric generating and a motor or other service station), and a telephone installation for interurban and long-distance service. The diffence between the two cases may be likened to that between a horse tramcar jogging along through a town at the rate of 8 kilometres per hour and an international express train covering a distance of thousands of kilometres at the rate of 100 kilometres per hour.

INFRINGEMENT NOTICES IN OHIO.

The Central Union Telephone Company has sent out notices from its offices, at Lima, O., to subscribers of opposition telephone lines in Northwestern Ohio, notifying the users of the telephones that they are using instruments which are an infringement on their patents. This is taken as a warning that suits will soon result.

BELL TELEPHONE STOCK.

Commissioner of Corporations Endicott, of Boston, has ruled that $200 shall be the price of the 21,500 shares of the new Bell Telephone stock, which is to be offered to stockholders before the sale by auction.

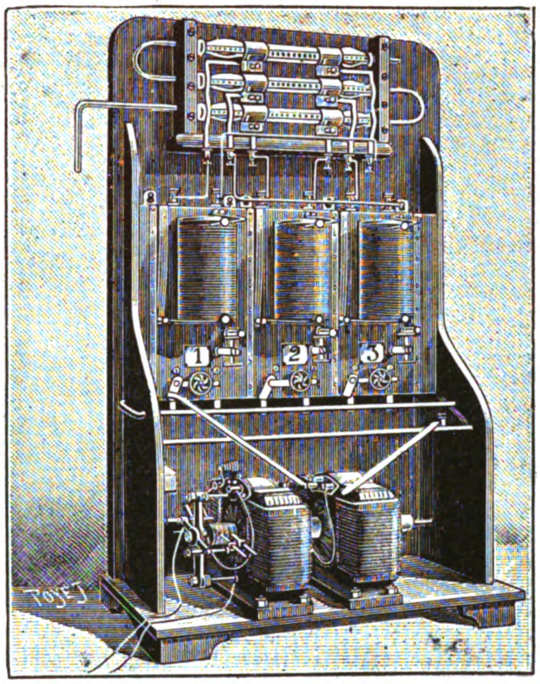
MR. ALBERT L. TUCKER, who has been for several years past connected with the Western Electric Company, Chicago, has been made manager of the supply department of the same company in the place of Mr. E. M. Scribner, who resigned recently.

MISCELLANEOUS.

OZONE GENERATOR OPERATED BY ELECTRIC MOTOR.

THE value of ozone in medicine, the bleaching of tissues, the rectification and artificial aging of wines, and the sterilization of water, air, etc., are well known, but the apparatus usually employed for that purpose is quite cumbersome. M. G. Séguy, after studying and operating a number of models, has arrived at the type of ozone generator illustrated in the accompanying illustration, taken from "La Nature."

On the upper part of a vertical board is mounted the tubular generator proper, consisting of three glass cylinders connected to one another, so as to effect a complete circulation, and leaving the two ends free or open. Each of these cylinders incloses a core of seven tubes, surrounded inside and outside by



THE SEGUY OZONE GENERATOR.

aluminum helices. The current derived from the machine to be described below traverses all these tubes, one pole being connected to the external helices, and the other pole to the internal. Consequently the current to complete the circuit has to pass through the glass, during which operation there are formed myriads of small sparks. This system of helices, consisting of 2,400 turns, has the power of considerably increasing the production of ozone.

The air is taken in by the bent tube shown at the upper left-hand corner, passes successively through the three tubes, and comes out at the other end, after being transformed into supersaturated ozone.

The electric current is furnished by the three secondary circuits of the induction coils, marked 1, 2 and 3, which give 30,000 volts. The primary circuits of these are fed by a small dynamo, placed at the left side at the bottom of the case. This machine furnishes a potential of from six to eight volts, and fifteen to eighteen amperes. The dynamo is driven by a motor mounted on the same shaft, the motor being connected to the city distribution circuits. By this arrangement it is possible to have a continuous production of ozone without much difficulty.

This tubular generator, according to the speed of the interior gases, and according to the section of the discharge tube, can furnish about nine cubic meters per hour of ozonized oxygen, that is, about fourteen to twenty milligrammes per litre.

MR. T. R. MERCEIN, of Milwaukee, the secretary of the Northwestern Electrical Association, has been appointed by the board of directors to represent the association at the New York convention of the National Electric Light Association. This fraternal action is highly appreciated.

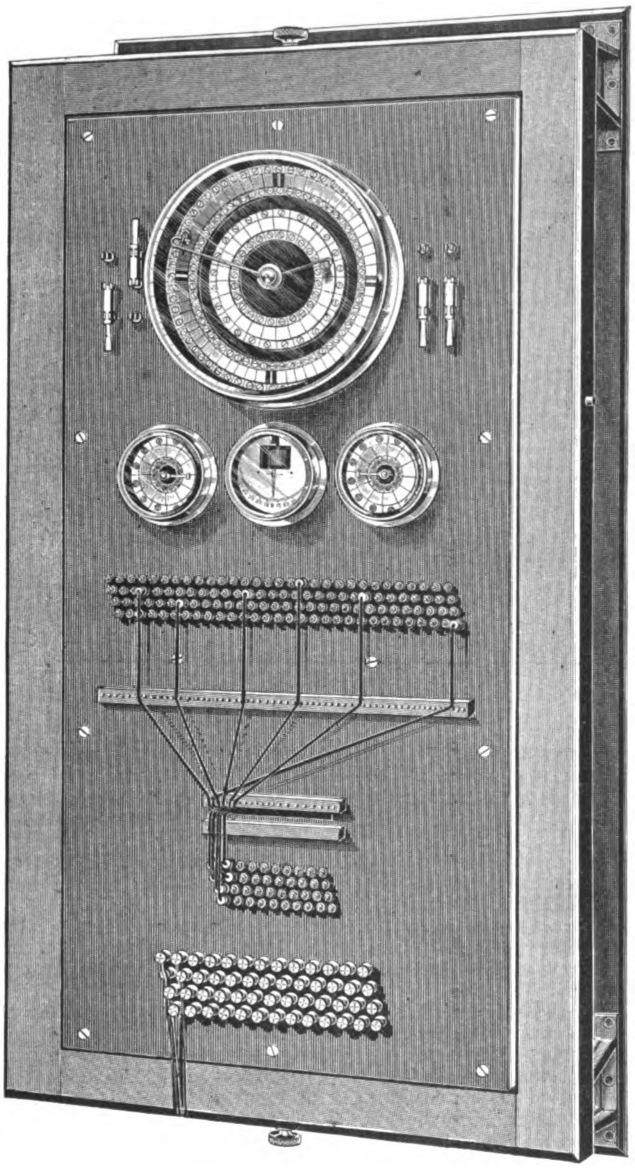
MULTIPLE CIRCUIT CLOSER.

BY

Ernest K. Adams

THIS device is designed to close any number of circuits, at any hour and minute of the day, each independently of the others. It consists, primarily, of a self-winding movement, arranged so that the hour hand makes but one revolution in twenty-four hours. At the extremities of the hands are placed platinum brushes, which sweep over rings cut into sixty and twenty-four segments, respectively, and any circuit having been connected to two segments, one in each ring, will be closed when a bridge is formed between these two by the hands. Excellent contact is obtained by means of a small spring in each brush, which keeps it constantly pressed against the brass.

It is requisite that the circuits should be absolutely independent of each other, in order to secure proper closing of the same. Where circuits are not mutually distinct it is sometimes necessary to employ relays.



ADAMS MULTIPLE CIRCUIT CLOSER.

The clock movement is placed at the back of a wooden frame pivoted vertically in a larger one fastened to the wall. On the front of the small one is a rubber slab, at the top of which, in a brass case, are the above mentioned rings. Each circuit enters at the bottom, and, passing up by means of cords, selects its hour and minute at which it is designed to be closed from the bank of screws, which are connected to the various segments above. These cords are kept taut by weights at the back.

Every hour, when the clock winds itself, the hands in the smaller cases are moved one segment, and, by placing several sets of batteries, preferably dry, in connection with these segments, a new group will be placed in circuit every hour or more, depending on the wiring and the number of sets used. It will be seen that by this arrangement a store (so to speak) of electricity may be laid in and drawn upon intermittently, thereby giving great length of life to the clock and requiring almost no attention whatever.

A galvanometer indicates, when the switches on the left are "thrown," the exact condition of the batteries then in circuit. The right hand switches may be used for winding up the movement, if, by any reason, it should fail.

Among the numerous applications of this apparatus may be mentioned the closing of circuits for: Starting and stopping machinery, opening and closing windows, registers, etc.; lighting or extinguishing either gas or electric lights; throwing on and off of burglar alarms; ringing gongs in schools, hotels and railway stations, and many other uses requiring certainty of action.

SOCIETY AND CLUB NOTES.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the 105th meeting of the Institute held at 12 West Thirty-first street, New York City, April 22, about 200 members and guests were present. A paper was read by Dr. D. McFarlan Moore, of Newark, N. J., member, on "Recent Developments in Vacuum Tube Lighting." It was accompanied by numerous experiments, and the hall was lighted with tubes which were suspended horizontally from the gallery in a double row. Owing to the lateness of the hour of adjournment there was no discussion.

At the meeting of Council in the afternoon the following Associate Members were elected: Bert L. Baldwin, Mechanical and Electrical Engineer, the Cincinnati Street Railway Company, 72 Perin Building, Cincinnati, O.; Chas. M. Clark, Student, Electrical Course, Columbia College, residence, 831 Madison avenue, New York City; William J. Clark, General Manager, Railway Dept. General Electric Company, 44 Broad street, New York City; Henry George Field, Consulting Electrical Engineer, Field & Hinchman, 25 Hodges Building, Detroit, Mich.; Curtis B. Flory, Student, Lehigh University, residence 530 Broad street, South Bethlehem, Pa.; Chris. M. Goddard, Secretary and Electrician, New England Insurance Exchange, Secretary Underwriters' National Electric Association, 55 Kilby street, Boston, Mass.; Wm. Steell Jackson, Electrical Engineering Student, Lehigh University, South Bethlehem, Pa., residence, Duncannon, Pa.; C. W. G. Little, Engineer, British Thomson-Houston Company, 38 Parliament street, London, Eng.; Chas. P. McCluer, District Inspector, So. Bell Tel. and Tel. Company, Richmond, Va.; Buckner Speed, Asst. Electrical Engineer, Louisville Electric Light Company, 1521 Fourth street, Louisville, Ky.; Robert M. Thomas, Asst. Chief Inspector, Bureau of Electrical Appliances, N. Y. Fire Dept., residence, 222 West Twenty-third street, New York City; Alfred A. Thresher, Electrical Engineer and proprietor Thresher Electric Company, Dayton, O.

The following Associate Members were transferred to Membership: W. S. Andrews, Electrical Engineer, etc., General Electric Company, Schenectady, N. Y.; Henry G. Stott, Electrical Engineer, Buffalo General Electric Company, Buffalo, N. Y.; Henry S. Carhart, Professor of Physics, University of Michigan, Ann Arbor, Mich.; Russell B. Harrison, President and Electrical Engineer, Terre Haute.

It was decided to accept the invitation of the National Electrical Exposition Company, and hold the annual general meeting in the Exposition building, beginning on May 19.

NEW YORK ELECTRICAL SOCIETY AT THE SPRAGUE FACTORY.

A large delegation of the New York Electrical Society visited the works of the Sprague Electric Elevator Company at Watsessing Junction on April 24 and inspected the large plant that is growing up there with such rearkable rapidity. Mr. Sprague himself received the party and entertained it with an offhand but graphic talk on electric methods as applied to vertical travel. A tour was then made of the shops, after which a collation was served by Mazzetti. The evening was most entertaining and instructive and adds another to the long list of the society's successes.

Exhibition Notes.

THE INTERESTING LOAN EXHIBIT FROM CORNELL UNIVERSITY.

DR. E. L. NICHOLS, of Cornell University, furnishes the subjoined list of the valuable and important apparatus, much of which is of historical as well as experimental interest, to be sent to the exposition. Professor Moler is to set it up there. As will be seen from the explanatory notes, the apparatus is such as to permit of a repetition of some of the investigations at the exposition, where they will be greatly enjoyed, not only by the public, but by experts. The exhibit comes specifically from the Department of Physics and Electrical Engineering of Cornell University.

1. Gramme Machine mounted upon Brackett Cradle.—Constructed in shops of Cornell University by Professor W. A. Anthony (summer of 1875), exhibited at the Centennial Exhibition (Philadelphia, 1876) and at the World's Fair (Chicago, 1893). Capacity, five arc lights, each with 20 amperes. It was in almost constant service from 1875 to 1893, and is still in good order. It was the first machine of the Gramme type built in America. The cradle upon which it was mounted was one of the earliest examples of the Brackett dynamometer, and was designed and constructed especially for this dynamo. It reads in kilograms per revolution.

2. A Reversing Switch.—For use with primary batteries. Designed and constructed by Professors Anthony and Moler for lecture room use, in 1875. (Original model.)

3. A "Doubler," or electrostatic accumulator, involving the principle of the electrophorus. Designed and constructed by Professors Anthony and Moler in 1878. (Original model.)

4. Arc Lamp for Projection (Focusing).—Designed by Professor Anthony, and constructed for him by the Brush Electric Company in 1887. One of the early attempts to simplify the mechanism of direct current arc lamps. (Original model.)

5. Small Double Coil Tangent Galvanometer.—Designed by Professor Anthony and constructed by Fred. C. Fowler, in the workshops of the Department of Physics. It was intended for the absolute measurement of electromotive forces. 1884. (Original.)

6. Early Form of Alternating Current Dynamo for Experimental Purposes.—Designed by D. C. Jackson and constructed by Fred. C. Fowler about 1885. (Original.)

8. Revolving Drum.—Constructed by Professors E. L. Nichols and W. S. Franklin for studying the direction of the electric current. It was driven during the investigations at the rate of 400 revolutions per second. ("American Journal of Science," vol. 37, p. 103, February, 1889. Original.)

9. Ryan's Electrometer.—The original instrument with which Professors Merritt and Ryan conducted their experiments upon transformers in 1889. Am. Inst. of E. E., vol. V., p. 6, 1889.)

10. Spiral Coil Voltammeter.—A much used copy of the original instrument designed and constructed by Professor H. J. Ryan, 1889. (Described at Amer. Inst. E. E., May 22, 1889, vol. VI.)

11. Horizontal-slit Photometer.—Designed by Professor E. L. Nichols and constructed by F. C. Fowler, 1890. This instrument was intended for the study of the spectrum of artificial light directly upon the photometer bar, and has been used in such work. (Am. Inst. E. E. May 21, 1890. Original.)

12.—Discharger used by Messrs. Archbold and Teeple in the study of the Ball and Point Effect.—A peculiar form of alternating arc discharge. (See "American Journal of Science," vol. XLI., 1891. Original.)

13. Alternate Current Potentiometer.—Designed and constructed by Professor G. S. Moler in 1891. It takes the place of an alternate circuit voltmeter, and gives results accurate to within 0.1 per cent. (Am. Inst. E. E., May 21, 1891. Copy of the original.)

14. Curve Writing Voltmeter.—Designed by Professor G. S. Moler and constructed by F. C. Fowler (1892). This instrument, which was used to record the rapid fluctuations of current and potential met with in dynamo practice, etc., was described at the American Institute of Electrical Engineers, June 6, 1892. It has been superseded by the galvanometer of Hotchkiss and Millis, No. 22 of this collection. (Original.)

15. Experimental Transformer.—Designed by Professors Bedell and Crehore (1891) for special investigations of the transformer, with particular reference to effects produced by an alternation of the reluctance of the magnetic circuit. This transformer was used in the experiments of Professor Bedell on the experimental determination of transformer diagrams. (Proceedings of the International Electrical Congress, Chicago, 1893. Original.)

16. Automatic Printing Speed Counter for Dynamo Shafting. —Designed and constructed by Professor G. C. Moler (1893). The apparatus exhibited, which is the original model, has been in continuous service since 1893. (Am. Inst. of E. E., May 17, 1893.)

17. Apparatus for Studying the Heating of Armatures.—Designed and constructed by Messrs. A. H. and C. E. Timmerman (1893). For the investigations performed by means of this apparatus, see Am. Inst. of E. E., vol. X.

18. Alternating current dynamo, constructed in the shops of Cornell University by Messrs. Smith and Hall. (Original.)

19. Water Jet Instantaneous Contact Maker.—Designed by Professors Bedell and Ryan, and constructed by F. C. Fowler (1893). This instrument is used in the study of transformers and other alternating current investigations where the instantaneous values of the varying currents and e. m. f. are to be determined. (Am. Inst. of E. E., Oct. 18, 1893. Original.)

20. Wooden Drum, with coils of wire, used in the experiments of Professors Nichols and Franklin upon the condition of the ether surrounding moving bodies. The drum, which was constructed with a galvanometer, is capable of indicating a current of 6×10^{-10} amperes. It was driven at 3,600 revolutions and suddenly stopped. Such was the delicacy of the apparatus that the absence of effect upon the galvanometer served to show that less than one hundred thousand million millionth of the rotating coil depended upon the rotation of the ether produced by its rotation. (Physical Review, vol I., p. 426, 1894.)

21. Phase Indicator for Alternate Current Motors, etc.—Designed and constructed by Professors Moler and Bedell, for determining the changes in the armature lag of alternate synchronous motors under varying conditions. (Described before the Am. Inst. of E. E., May, 1894.) This instrument was employed in the experiments upon the synchronous motor described by Professors Bedell and Ryan. (See Journal of the Franklin Institute, March, 1895. Original.)

22. Hotchkiss and Millis Galvanometer for the photographic recording of alternating and oscillatory currents. In the example exhibited, which is one constructed and used by them, the mirror has a very small period of vibration.

23. Set of Negatives obtained with the Hotchkiss and Millis galvanometer.

24. Laboratory Transformers.—Designed and constructed by Messrs. J. Swann and H. E.Mole (1896). This transformer is one of a number constructed in the laboratory with particular reference to students' use. (Original.)

25. Apparatus for the measurement of telephonic or minute alternating currents. This exhibit is the original dynamometer used in making telephonic current measurements with the polyphase current method devised by Professor H. J. Ryan. ("The Electrical World," June 23, 1894.)

26. Two-phase Rectifying Commutator used by Messrs. Barnes and Stillwell, under the direction of Professor H. J. Ryan to determine the utility of inductance for constant current regulation from "open coil" or other forms of polyphase generators.

27. Sample of Sheet Iron formed as desired by etching process, applied by Professor H. J. Ryan for the productions of laminated portions of experimental alternate current machinery, avoiding the use of dies too expensive for experimental purposes.

28. Alternate Current 300 Ampere Balance, in which the flexible connections are made of silver foil, designed by Professor H. J. Ryan and constructed in the workshops of Cornell University by Messrs. Tobey and Walbridge. (1890.)

29. The Original Westinghouse Ten-Light Transformer and Switchboard, used by Professors Merritt and Ryan while making their transformer experiments in 1889. (Am. Inst. of E. E., vol. V., p. 6, 1889.)

30. Special Form of Mechanical Contact Maker for obtaining alternate current curves. Used by Professor H. J. Ryan when determinating the behavior of a 17,500 watt transformer in 1892. ("The Electrical Engineer," N. Y., September 28, 1892.)

31. Photograph of a 30,000 Volt, 10 k. w. Transformer, stepping up from 100 volts at 50 p. p. s. Designed and constructed in the workships of Cornell University by H. B. Plumb, 1895. (Described in the Sibley Journal of Engineering, June, 1895.)

TO MEMBERS OF THE A. I. E. E.

At the meeting of the American Institute of Electrical Engineers on ednesday, April 22, a silver matchbox was lost. The matchbox is enamelled in white on one side, a burning cigar with the motto "It all ends in smoke" forming the only too apt design on the enamel. On the reverse side are engravd a crest and motto and monogram, and on the lid a date is engraved. The finder will confer a great favor by communicating with the secretary of the institute.

THE STEAM AND ELECTRIC PLANT OF THE NATIONAL ELECTRICAL EXPOSITION.

IN presenting to the public an exhibition of electrical machinery and appliances which included practically everything of consequence in this line, the National Electrical Exposition Company decided that such an exposition would not be complete without a steam boiler plant up to date in every sense of the word, whereupon a special committee was appointed to secure a strictly modern plant including the leading appliances in the market.

The improved Root water tube boiler, manufactured by the Abendroth & Root Manufacturing Company of New York, was selected to furnish all the steam used at the exposition, there being two equal units forming one battery of five hundred horse-power of boilers. The well known anthracite automatic stoker, manufactured by the Wilkinson Manufacturing Company of Bridgeport (Montgomery County), Pennsylvania, was selected to handle the coal supplied to the fire.

The coal, after being dumped at some distance from the boilers, in the rear, is taken by the C. W. Hunt coal conveyor and carried along the side and a little past the front of the boilers, where it is elevated to a point near the ceiling, from whence it is delivered through tubes to the hoppers of the Wilkinson stokers and, of course, from that point it is fed uniformly down the inclined grates, burning on its way and reaching the foot of the grate as ash, and finally we find it dumped into the ash pit below.

The Hunt conveyor next takes the ash and carries it back to a dumping place some distance in the rear of the boiler, dumping it there automatically. Thus we find the fuel well cared for automatically.

The question of boiler feed-water is fully as important as the coal supply. The water of New York City being exceptionally well adapted for boiler use, no filters or purifiers were considered necessary. The pump supplying feed-water to the boilers is one of the H. R. Worthington Company's make. It will be electrically driven by one of the Crocker-Wheeler Company's pump motors. The pump is one of the "steeple pattern," and combined with its motor presents a novel and elegant appearance.

Two of the Root feed-water devices, manufactured by the Abendroth & Root Manufacturing Company, will work in connection with the boilers, the feed-pump starting the pump automatically when the water level in the boiler falls below its proper level and again stopping the pump when the water in the boilers tends to rise above its normal working level. Thus far the entire working of the boiler is made automatic with the exception of the damper regulation, and here the Locke Damper Regulator Company of Salem, Mass., come to the rescue with one of their damper regulators, and this completes the entire automatic equipment.

So safe and so simple is the operation of this plant, that it has been decided to put it in the charge of a woman to show conclusively that if steam users will put in the best of everything that the market places at their disposal and if they will equip their plants in an up to date manner throughout, they will become so simple in their operation that a woman can operate them as well as the most expert fireman.

The visitor to this exposition will find many other very attractive and useful features which will well repay his careful investigation. The valves, used in the main steam piping, for instance, are especially adapted to high pressures and the usual rough handling. They are heavy straightway valves with an outside yoke and screw, made by the Chapman Valve Company, of Indian Orchard, Mass.

The pressure carried by the boilers will be 125 pounds. This pressure will be carried along the main steam piping to a point just beyond the first engine and there it will be reduced by a Foster reducing valve to 90 pounds, at which pressure it will be carried to all of the other engines on exhibition.

It will be interesting to follow the steadiness of the working of this reducing valve. This may be done by going to the exhibit of the Ashcroft Manufacturing Company near by, where two Edison recording gauges wil be found in operation, one recording the pressure of steam at the boiler and the other gauge recording the pressure on the low pressure side of the reducing valve. The Foster Engineering Company will also exhibit their new automatic safety stop valve, to be placed in the main steam pipe near the boiler. This valve will instantly and automatically close in case of a rupture in the steam pipe, or the breaking of any of its fittings. By this means, the steam in the boiler will instantly be stopped from rushing into the piping and such terrible fatalities as have recently occurred due to ruptured steam pipes will be avoided.

Another valuable feature used in connection with this automatic safety stop valve is found in a pipe leading from it containing a quick closing lever gate valve. When this is opened quickly, the main valve closes instantly, and thus the whole steam supply can be cut off from the main steam pipe at an instant's notice.

The boilers are equipped with steam gauges manufactured by the Ashcroft Manufacuring Company, and with nickel seated pop safety valves made by the Consolidated Valve Company, of New York and Bridgeport, Conn.

The visitor cannot fail to be struck with the beautiful finish of the boilers, which have been designed to include utility, durability, and elegance in outline.

The fine smooth black finish contrasting so strikingly with the polished nickel work is produced by the use of Dixon's graphite boiler front paint, made by the Joseph Dixon Crucible Company, of Jersey City, N. J., whose exhibit will be found in the neighborhood of the boilers. The mason work is certainly of exceptionally fine appearance, and is most creditable to the mason, Garret S. Wright, of New York.

The exhaust piping from the eleven engines will probably interest many of the visitors to the exposition, as it has been used by so many electric light companies for this purpose. We refer to the spiral riveted pipe made by the Abendroth & Root Manufacturing Company.

The battery of improved Root boilers used at the exposition is an exact duplicate of the twelve batteries of boilers used at the celebrated tunnel plant of the Baltimore & Ohio Railroad in Baltimore, Md.

A fine photograph of exceptional size, showing this plant, will be seen on the wall near the boilers.

The engines on exhibition will all be direct connected with generators, with two exceptions, which will be connected by belting.

The engines will be found arranged in the following order, beginning with the engine nearest to the boilers: The Phœnix Engine (the only compound engine); Ball & Wood engine, Straight Line engine, Harrisburg engine, Watertown engine, Payne engine, McEwen engine, Weston engine, (belted); New York safety engine, (belted); Case engine, Shepard engine, Woodbury engine.

The exhaust from all these engines will be passed through a Goubert feed water heater, and then sent through the spiral riveted exhaust pipe (placed outside of the building) to a point above the roof. All the feed water used will pass through this heater, thus supplying the boilers with a bountiful supply of water heated to nearly 212 degrees.

Two concerns share the steampipe covering work, one putting on Keasby's magnesium sectional covering, while the other applies Gilmore's asbestos covering.

A COLLECTION OF INVALUABLE MORSE RELICS.

Mr. E. L. Morse, one of the members of the Historical and Loan Exhibit Committee, has prepared a remarkably interesting collection of early papers, models, relics, etc., relating to Morse, Vail, Henry, O'Reilly, L. D. Gale and others, and to the early days of the telegraph. As the son of Professor S. F. B. Morse, he has, of course, facilities enjoyed by no one else for the presentation of such matter, and the result of his efforts will be of great attraction to everybody. It is expected that this collection will be supplemented by other material from other contributors. The list furnished by Mr. Morse is as follows:

1. Copy of the first wooden telegraph apparatus. 2. Certified copy of the Sully sketch book. 3. Original pen and pencil notes of Morse relating to the telegraph. 4. Letters of Alfred Vail relating to the telegraph. 5. Letters of Peter Cooper. 6. Letters of Cyrus Field. 7. Original 1843 contract of Alfred Vail with Prof. Morse. 8. Piece of shore end of Atlantic cable. 9. Pocket telegraph instrument presented to Prof. Morse by J. D. Caton. 10. Decorations and medals received by Prof. Morse from European governments. 11. Marble bust of Prof. Morse by Horatio Greenough. 12. Portrait of Prof. Morse by Edward L. Morse. 13. Frame containing the following photographs: Birthplace of Prof. Morse, in Charlestown, Mass.; church where Morse was baptized; residence, Poughkeepsie; residence, New York; Academy of Design, copy of "Dying Hercules;" statue in Central Park; monument in Greenwood cemetery. 14. Letter of S. F. B. Morse written to his parents in 1799, when Morse was eight years old. 15. First picture painted by Morse, at the age of fifteen; a family group of his parents, his brothers and himself. 16. A few of Prof. Morse's sketch books. 17. Daguerreotype of Prof. Morse and his eldest daughter, taken by himself in 1840 or 1841, one of the first ever taken in America. 18. Letters from George Wood, Henry O'Reilly, Amos Kendall, Prof. L. D. Gale, William W. Pell, Prof. Benjamin Silliman and others. 19. Caveat for a mode of filling pipe with wire (MS.). 20. Miscellaneous papers, etc.

WHAT EXHIBITORS WILL DO.

NOW that the opening of the National Electrical Exposition is so near, exhibitors are straining every nerve to be ready on time and to make a fine display. We have already given details of what many of them will do, and are now able to supplement that news with further data.

The Electric Storage Battery Company of Philadelphia, besides furnishing the cells charged with Niagara energy which are to run the Niagara model, when "live juice" is not available, will have the following as part of their regular exhibit:

Storage battery of 128 cells in operation, capable of supplying 400 16 candle power lamps (suitable either for central stations or isolated plants) used in conjunction with the Edison system, charged during hours of light load, when current is supplied at a special rate.

Under this method, installations have all the advantages of a storage battery reserve, without the trouble incident to a generating plant, and the cost of light and power compares very favorably with that of isolated generating plants.

Motor driven booster for charging battery in connection with the Edison system, built by the Electro-Dynamic Company, Philadelphia, Pa.

White marble switchboard in oak cabinet, showing latest type of controlling apparatus for storage battery work.

Electric carriage propelled by storage batteries (designed by Morris & Salom). Similar to carriage which won the gold medal in Chicago road race.

Electric launch, 21 foot, propelled by storage batteries, handsomely finished with mahogany and natural wood.

The exhibit will be in charge of Mr. Chas. Blizard, assisted by Messrs. R. W. Rundle, W. O. Knudson and T. B. Entz.

The Adams-Bagnall Electric Company, of Cleveland, will exhibit one of the largest lines of arc lamps ever seen, as the product of a single concern. They will have on exhibition and running a black japan series lamp, shunt; a seventeenth century brass series lamp, differential; an oxidized copper 100 hour lamp, 1,600 alternations; a Japanese copper alternating lamp, 1,200 alternations; an oxidized silver constant potential lamp; an oxidized brass constant potential lamp; a marine lamp, black japan; a 100 hour old gold lantern. There will also be railway arc lamps to run nine or ten in series on the railway circuit. All of them will be of the improved A. B. pattern, about which so much has been said and written of late. The A. B. incandescent lamp will also be shown in its various sizes and styles, all of which have the bulb smoothly rounded and free from the protuberance or nipple that is common to the older forms of incandescent lamps. All lamps, both arc and incandescent, will be open to fullest inspection and test, and measuring instruments will be in circuit.

The Crane Company, of New York City, are exhibiting samples of their specialties, such as extra heavy I. B. gate valves, both with and without by-pass, for 250 pounds working pressure; extra heavy I. B. globe and angle valves for 250 pounds working pressure; pop safety and water relief valves, standard and indicator; extra heavy flanged fittings, plain, tongued and grooved; extra heavy brass globes; also gate valves for 250 pounds working pressure. These will be supplemented by much minor detail apparatus.

The Joseph Dixon Crucible Company, of Jersey City, have space No. 126, section F, on the main floor, where they will give a very interesting exhibit of their graphite and graphite products as related to the electrical and allied industries.

The Niles Tool Works, of Hamilton, O., will exhibit at the National Electrical Exhibition three machines, namely, a five-foot radial drill, to be driven by a motor placed on the floor; a No. 1 horizontal boring and drilling machine driven by a constant speed motor attached to the countershaft; and a thirty-seven-inch boring and turning mill that will be driven by an electric motor attached directly to the driving shaft.

The Brush Electric Company, of Cleveland, Ohio, will occupy no less than 425 square feet with their exhibit at the Electrical Exposition. It will be composed of a historical exhibit and a modern exhibit, the former of which is very old and the latter very new. The historical exhibit will consist of the first Brush arc dynamo which was sold in 1877 to parties in Baltimore who ran it for twelve years. A sixteen light 2,000 c. p. arc dynamo which was run by the Fulton Worsted Mills, Fulton, N. Y., from September 1, 1879, to April 10, 1892, when it was secured for exhibition at the Columbian Exposition. A forty light Brush arc dynamo which was operated by the Berkeley Company in Providence, R. I., from December 1, 1881, to May 19, 1893, when it was purchased for exhibit at the Columbian Exposition. These dynamos are exhibited just as they left the factories years ago. Not a bobbin of an armature has been re-wound, nor a shaft wire or a commutator replaced.

The working exhibit will consist of a new 80 light 2,000 c. p. Brush arc dynamo connected direct to a 60 k. w. 220 volt motor. Eighty double Brush arc lamps will be hung gracefully around the exhibit and operated from the direct connected dynamo.

In connection with the direct connected 80 light arc dynamo will be shown in practical operation a machine running with a load of 80 lights with a difference of potential not exceeding 1,500 volts between any part of the machine or circuits and the machine still maintaining its automatic regulation. To put it more plainly, three circuits will be run direct from the terminals of the dynamo on any one of which circuits the voltage will not exceed 1,500 volts, or in other words, on any one of which circuits there will not be more than 27 2,000 c. p. arc lights. This is an entirely new method of running lamps on an arc dynamo and will be exhibited for the first time in the Brush exhibit.

There will be a 100 light 2,000 c. p. Brush arc dynamo and a 125 light 2,000 c. p. Brush dynamo exhibited. These three large arc dynamos are of the very latest Brush type. They have been recently designed by the Brush Company who have already sold over 20,000 lights capacity of them.

A rack of the various styles of lamps which the Brush Company manufacture will also be exhibited.

TRAVELING ARRANGEMENTS FOR DELEGATES.

The various passenger associations have granted the rate of a fare and a third, on the certificate plan, to delegates attending the convention of the National Electric Light Association, to be held in New York, May 5, 6 and 7. It is positively necessary that delegates when purchasing tickets should state to the agent that they are delegates to the convention of the National Electric Light Association and should obtain from him a certificate that they have paid full fare, which certificate, when properly signed in New York, will entitle them to return passage at one-third the regular fare. It is absolutely necessary that this certificate be obtained when tickets are purchased; otherwise, it will be impossible to take advantage of the reduced rate returning. These certificates are good going three days prior to the opening of the convention and are good to return only three days after the adjournment. The Electrical Special will leave Chicago Saturday, May 2, at 5:30 p. m., via Lake Shore and Michigan Southern road, arriving in New York at 6:30 p. m. Sunday, May 3. Accommodations on this train may be secured by addressing either W. A. Kreidler, 510 Marquette Building, or C. K. Wilber, Western passenger agent L. S. & M. S. R. R., Chicago, Ill. The indications are that this train will be a very heavy one, and Mr. Kreidler has arranged all the details so that it will be as fine a convention train as ever run, if not the finest.

A DOREMUS HISTORICAL EXHIBIT.

A striking figure in the intellectual development of New York throughout the last half of the century has been Dr. R. Ogden Doremus, of the College of the City of New York, Bellevue Hospital, and other prominent institutions. He has always taken an active part in the advance of electricity as a section of the domain of physics and chemistry, and is manifesting deep interest in the National Electrical Exposition. In spite of pressing duties, he has, with the aid of his son, Prof. C. A. Doremus, gathered together some of his more interesting apparatus, and is contributing a display which after all is but the merest fragment of what might be shown and which is exclusive of the working apparatus to be placed in the "Practical Laboratory." It includes, for example, Henry's own experimental induction coil; the famous "Tithonometer" devised by Prof. J. W. Draper in 1842; a "Tithonotype" or copper electrotype of a daguerreotype, and a daguerreotype, taken by the doctor in 1844; electrolytic Marsh apparatus made by Dr. Doremus in 1860; a quantity battery of which the carbons were obtained from iron gas retorts in 1854, each weighing 90 pounds. There will also be two large prisms, 9 inch aperture, for projection of the spectra of metals, each holding 10 pounds of bisulphide of carbon.

These rare scientific curios will be supplemented by one of the cells of the historical old 500 cell battery used at the College of the City of New York, apparatus for fusing metals, apparatus for combustion of explosives in vacuo, and other rare, odd and beautiful things.

AN X-RAY LECTURE FOR THE CONVENTION.

Having in mind the intense interest felt in all that pertains to Röntgen X-rays, the National Electric Light Association has arranged for a lecture on the subject during the convention next week, and has asked Mr. Max Osterberg to give it, with as many experiments and illustrations as possible. This will be brilliantly aided, of course, by the Edison exhibit, which it will in turn serve to explain. Mr. Osterberg has the subject thoroughly in hand and has accumulated a great deal of unique data and material bearing upon it. The lecture is to be given on the evening of May 5.

A PRACTICAL WORKING LABORATORY FOR THE EXPOSITION.

SO many important and interesting pieces of working scientific apparatus, illustrative of some electrical principle or employed in some investigation, have been placed at the disposal of the Exposition management by universities, colleges, and inventors, that special provision has been made for their expert care, so that they can wherever possible be seen in operation by the public. With this object in view, most of this interesting apparatus has now been massed into what will be known as "A Practical Laboratory," in which will be placed all pieces with which experiments or investigations of an educational nature will be made. This will enable the public to witness some striking phenomena, many of which have rarely been demonstrated hitherto outside of the walls of a college or private laboratory.

In order to give proper supervision to this laboratory the Exposition Company has asked Mr. Max Osterberg, of Columbia University, to act as its curator, and that gentleman has very kindly consented to serve. His familiarity with such apparatus and his skill as an experimenter promise a brilliant success for this novel department, which, it is said, has never been organized before at an Exposition, but which realizes in a marked degree the educational purposes underlying the plans of the management.

Mr. Osterberg is now laying out the plans for showing every piece of apparatus to its best advantage. His principal aim is to have everything in such condition that the public can be made to understand some of the most difficult points in electrical engineering within a few minutes. In that way the electrical laboratory becomes a directly educational feature, and if that end is achieved, Mr. Osterberg will feel amply rewarded for the trouble and care bestowed on this exhibit.

Prof. Elihu Thomson is sending much apparatus which will be worked in this laboratory and the entire working instruments of Cornell will be under Mr. Osterberg's care, in behalf of the university.

Among the special attractions will be the material kindly furnished by Prof. R. Ogden Doremus, in behalf of the Bellevue Hospital, which represents also his personal work in connection with the college.

Mr. Osterberg will arrange, by permission of Prof. Crocker and Dr. Pupin, of Columbia University, a set of condensers to show the speed with which a message is sent through the transatlantic cables. A great many other attractive experiments are in store for curious visitors and inquiring students.

A MODEL OF THE ELECTRIFIED ERIE CANAL.

UPON the request of Mr. Frank W. Hawley, who has been so actively and prominently engaged in the application of electricity to the Erie Canal, Mr. Richard Lamb, the civil engineer and inventor, whose electric bank haulage system was put in operation last year at Tonawanda, has worked out a beautiful and costly model of the whole thing; and Mr. Hawley has placed it at the disposition of the National Electrical Exposition. It will be located as an adjunct to the model of the Niagara power plant, which is to stand in the center of the main floor; and the intention is to run it by some of the stored power from Niagara, switching over occasionally to the regular circuits of the building. The model is no less than 40 feet in length, 6 feet in height, and about 3 feet wide. The canal will have eight inches depth of water in it. There will be eight poles, five feet apart, and a one-fourth horse-power motor will furnish a more than liberal supply of motive power to a string of three boats. The latest innovation in canal and lake freighting is the use of steel barges, and the owners of these, the Consolidated Canal Company, who now have a large number afloat, have built three small facsimiles of their craft. The model is not strictly to scale, but the boats are. Each is two feet long. They have been dubbed respectively, Hawley, Lamb, and Wiman. As a setting to the view of the Erie Canal, with its miniature equipment of methods old and new, a scenic artist has painted an appropriate background of rural scenery. The whole thing is cleverly worked out, the "tow" going up the canal and back in about two minutes, the motor reversing automatically at each end of the section.

THE PATENT OFFICE EXHIBIT.

To ship the exhibit of the U. S. Patent Office of 360 models of electrical inventions, for the exposition, required thirty-eight cases. They weigh over two tons. Mr. W. A. Megrath, of the Patent Office, has been specially detailed by the Hon. S. T. Fisher, Acting Patent Commissioner, to take charge of the exhibit.

THE W. J. HAMMER HISTORICAL COLLECTION OF INCANDESCENT ELECTRIC LAMPS.

This collection of incandescent lamps, to be shown at the Exposition, represents to a very considerable degree "The History of an Art." It starts with original models exemplifying the early laboratory work of such men as Changy, Lodyguine, Edison, Sawyer & Man, Swan, Lane-Fox, Maxim, Weston and others. In many cases these inventors and experimenters are represented by numerous forms of lamps, showing in a most interesting way the development in the art as their knowledge and experience increased. To these must be added the following, who are among the many represented in this wonderfully interesting collection, and who by their work have contributed to the development and practical application of the incandescent electric lamp: Muller, Diehl, Siemens & Halske, Siemens Bros., Rogers, Gatehouse, Crookes, Boehm, British Electric, Duplex, Bernstein, Pray, Van Choate, Thompson, Thomson-Houston, Shaefer, Opperman, Vitrite-Luminoid, Novac, Woodhouse & Rawson, Excelsior, Beetz, Greiner, Reinman, Richter, Green, Latimer, de Khotinsky, Goebel, Packard, Stanley, White, Westinghouse, Hammer, Jenny "D. A. C.," Perkins, Cruto, Shultzberger, Sunbeam, Fitzgerald, Franklin, Moses, Kurtzgen, Alcester, Alexander, Gerard, "A. B. C.," Sun, Seel, Remington, Heisler-Bernstein, Victoria, Mather, Swan-United, Edison-Swan, Brush-Swan, etc.

This remarkable collection has been gathered from many quarters of the globe—America, England, France, Germany, Austria, Italy, Holland, Switzerland and other countries contributing. Mr. Hammer started the nucleus of it at Mr. Edison's laboratory in Menlo Park, where he was an assistant in the early days of Edison's work upon the incandescent lamp. Having charge of and assisting in many of the original experiments, tests, records, etc., he made a practice of collecting, with Mr. Edison's permission, certain lamps showing important steps in the work, believing they would some day be of great interest and value. Subsequently Mr. Edison gave him nearly all the lamps he had, which now form an excellent record of his work. To these Mr. Hammer has added from time to time during the past seventeen years. As five years of this period were spent in Europe, he secured many most valuable examples of the early lamps of the foreign inventors. Mr. Hammer also exhibits the only collection in existence of the early substances Edison tried in his endeavors to secure a practical filament for the incandescent lamp.

HEARING NIAGARA IN NEW YORK.

The amount of interest is remarkable that is being manifested in the proposition to enable people at the electrical exposition in New York to listen to the "roar" of Niagara. It is believed to be impossible, but it is not so, as the American Telephone and Telegraph Company will demonstrate next week. Indeed, it is said to be an often tested fact that over the long distance wires, even now, although not arranged for the purpose, the voice of the Falls can sometimes be heard. The company are, however, making plans so that several people can hear it distinctly at any hour and all at once. It is not necessary in making connection at the Falls to go behind the sheet of water in order to get the full effect of sound, but by placing the transmitter near the Horseshoe on the Canadian shore, all the tone and quality will, it is said, be clearly obtained.

The receivers, to the number of thirty or forty, will be grouped around the little model of the Niagara power plant, on the special central platform, in the main hall, so that people will see Niagara run and hear it at the same time; the model itself being also driven with live or stored current from the Falls. It is stated that the "note" of Niagara is four octaves lower than the keyboard of the ordinary piano. Mr. Eugene Thayer, the celebrated organist, says it is not a "roar" at all but a "perfectly constructed musical tone, clear, definite and unapproachable in its majestic perfection; a complete series of tones, all uniting in one grand and noble unison as in the organ." Mr. F. A. Pickernell, the electrical engineer of the American Telephone and Telegraph Company, is now making all the arrangements for this really unique entertainment which will be open to all visitors to the Exposition.

A NOTABLE COLLECTION OF PORTRAITS.

A collection of over 200 autograph portraits comprising all the great celebrities of the electrical art and a number of men now rising to prominence or active in the field has been formed by Mr. W. J. Hammer. These, in nine handsome, framed groups, have been loaned by him to the Exposition, where they will be appropriately displayed. The collection not only includes Americans, but is rich in rare photographs of the leading electrical spirits of Europe.

RELICS OF THE TELEGRAPH.

Mr. A. B. Chandler, president of the Postal Telegraph Cable Company, has loaned the Exposition an interesting frame of very early relics of the telegraph. It contains a piece of the wire used by Morse and Vail at the Vail-Speedwell Iron Works; a piece of tape that is indented with the signals transmitting the news of Henry Clay's nomination; picture of the famous Speedwell shop—then and now;—a portrait of Vail and some views of the early experimental apparatus.

AN EXHIBIT OF GEDNEY'S CHANNEL BUOYS.

One of the most picturesque features of New York Harbor at night is the lane of electrically lighted buoys that marks the passage through Gedney's Channel at Sandy Hook. This is a unique installation, the current being supplied to the buoys from the shore through long runs of submarine cable. These buoys are huge spars of wood, sixty feet long, floating at a slight incline from the vertical, the lamp being carried like the head of a walking stick, and the submerged end being anchored by an iron mushroom weight. The United States Lighthouse Board has kindly placed two of these buoys, ready for lighting, one direct current and one alternating, at the disposition of the exposition management. They will be shown in a length of twelve feet, upright, and the Bishop Gutta Percha Company has been good enough to offer runs of cable to carry current to them, of the same type as that actually supplied for the real work. These buoys will be placed near the entrance to the exposition, with charts and pictures, and the visitor will thus be able to understand how the thing works. Such an exhibit has never before been made, and as stated already, there is thus far only one such installation in the world.

MARRIED.

PALMER—JOHNSON.

Miss Edna Earle Johnson, daughter of Mr. and Mrs. Edw. H. Johnson, of Madison avenue, was married in St. Agnes's Protestant Episcopal Chapel, on April 22, to George Quintard Palmer, son of Mr. and Mrs. Nicholas F. Palmer.

The ceremony was performed by Bishop Quintard, of Tennessee, an uncle of the bridegroom, assisted by the Rev. Dr. E. A. Bradley, vicar of the chapel, and the Rev. Dr. Bruglar, of Port Chester, N. Y.

The bride wore a handsome gown of white satin, trimmed with old point lace, and carried a shower bouquet of orchids and roses.

Her sister, Miss Lillian Johnson, acted as maid of honor. The bridesmaids were Miss Maud Quintard, Miss Laura Belle Spraker, Miss Mabel Adams and Miss Agnes Ely. Frank Fletcher Palmer, a brother of the bridegroom, was the best man, and the ushers were Frederick Palmer and William A. Slayback.

A large reception at the home of the bride's parents followed the church ceremony. The wedding guests included a large number of electrical people, friends of the Johnson family. Some of them came across the continent for the ceremony.

OBITUARY.

MRS. M. I. PUPIN.

We note with deep regret the sudden death of the wife of Dr. M. I. Pupin, of Columbia College, this city. Mrs. Pupin had been in constant attendance upon her husband, who lay seriously ill, and when informed by the doctors that he was at last out of danger, the reaction proved too much for a weak heart and enfeebled system. Dr. Pupin has the sympathy of a host of friends.

RICHARD THOMAS.

We regret to note the death of Mr. Richard Thomas, president of the well known porcelain manufacturing house of the R. Thomas & Sons Company, of East Liverpool, O., whose products are in large use throughout the electrical industries. Mr. Thomas was sixty-eight years of age.

MR. F. JEWETT.—The death is announced of Mr. Francis Jewett, a well-known citizen of Lowell, Mass., and one of the Erie Telephone Company.

Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

THE BULLARD TRANSFORMER.

CENTRAL station managers throughout the country are realizing that it is the absence of the constant loss on open secondaries, or what is usually termed the leakage current, which is constantly passing through a transformer,

FIG. 1.—THE BULLARD TRANSFORMER.

whether the lights are on or not, that constitutes the actual economy of a converter. Comparatively speaking, there are but a few transformers on the market at present that realize in any measure the ideal of what a converter should be. But after a long series of experiments, the Bullard transformer,

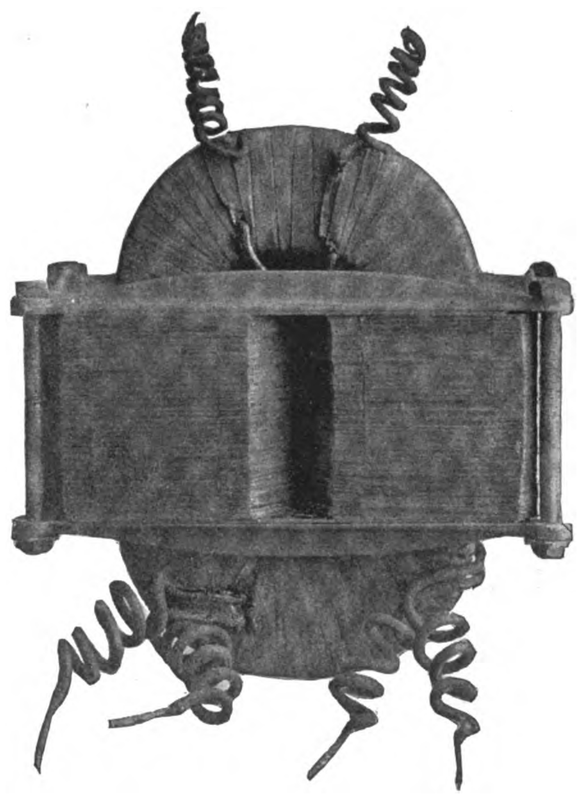


FIG. 2.—THE BULLARD TRANSFORMER.

that has just been placed upon the market, claims to offer to the central station a higher degree of economy than has yet been considered possible when combined with close regulation.

The Bullard Electric Company, of 1563 Monadnock Block, Chicago, manufacturers of the Bullard transformer, have been actuated in their experiments by the belief that many plants in the country desire the most economical converter obtainable, without reference to the slight existing difference in first cost. This company claim that they will readily demonstrate, by offering their transformer for service test, that a net saving of $4 or $5 per year per thousand watt converter capacity can be made by the use of the Bullard converter over the highest grade transformers heretofore upon the market.

A most recent and exhaustive test, made by Prof. H. S. Carhart, of the University of Michigan, on a twenty light or 1,000 watt transformer, is given below:

Efficiency.	Per cent.	Regulation.	Per cent.
Full load	95.18	Full load	2.52
¾ "	95.11	¾ "	2
½ "	94.47	½ "	1.27
¼ "	91.66		

Watts loss on open secondaries: 23.6. Rise in temperature after more than one hour with full load: 21 deg. F. The larger sizes are, of course, proportionately better.

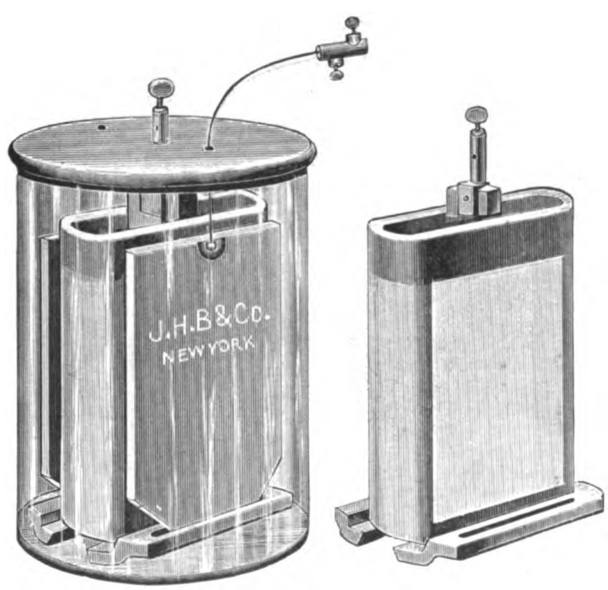
All of the Bullard transformers are made with the greatest care, only mica insulation being employed. Before finally taping the coils, they are thoroughly saturated and boiled in a compound of the highest insulating qualities, and are then baked to a solid mass by being subjected for several days to a high temperature. The transformers are made either for 2,000 or 1,000 volts primary, as may be desired, and for two reductions on the secondary.

Fig. 1 shows the transformer in case ready for installation. Two hooks for adjusting to cross arms are packed with each transformer, so that they may be expeditiously installed on poles. Fig. 2 shows the general arrangement of the coil, ready to be placed in the case. A desirable feature of this transformer is that the coils are not in any way bolted or screwed into the case, the arrangement being such that the bolting down of the cover holds the coil in a firm and rigid position.

The Bullard transformer is made with detached fuse box, as the old method of having fuse box attached to the case of the transformer is attended with so many difficulties in replacing fuses, that it is rapidly becoming obsolete.

THE WHEELOCK BATTERY.

THE accompanying engraving represents the new Wheelock battery, manufactured by Messrs. J. H. Bunnell & Company, of New York. This cell possesses the great advantage of giving two volts and has a capacity of 100 ampere-hours. It accomplished this owing to the peculiar construction of the cell, together with the nature of the strong depolarizing char-



THE WHEELOCK BATTERY.

acter of the solution employed. Inverted T-carbons are permanently set in the porous cup, and flat rolled zinc plates are placed on either side of the porous cup. The zincs at their lower ends dip into mercury troughs which keep them amalgamated automatically. The solution employed is a mixture of sulphuric acid and chromic salts with water, and can be renewed at a cost of 5 cents. The cell is pre-eminently adapted for continuous closed circuit work and can be left on open circuit for as long a period as two months.

AN ALUMINUM FLUOROSCOPE.

BY J. A. LE ROY.

Accidents have led to many discoveries, and a little accident caused me to investigate and bring about the following result: While preparing a fluorescent screen, a small amount of the solution which I used to secure the crystals of tungstate of calcium spilled upon a sheet of tin, upon which it was customary for me to place the cardboard and apply the tungstate. While applying the same to the cardboard the moist spot on the tin plate became coated also. Desiring to know what effect the Röntgen rays would have upon metal coated with tungstate of calcium, I prepared screens made of various metals and coated them with crystals. I compared the metal screens with the ordinary cardboard screens and found that the aluminum screen gave better results; the outline and articulation of the bones of the hand stood out in bold relief and detail. The aluminum being more porous to the rays, evidently allowed them to penetrate to a greater degree than the cardboard. While testing the fluoroscopes, I excited a phosphorescent screen by means of an ignited magnesium tape. After the tape ceased burning, I found, on looking at the phosphorescent screen, fluorescence was caused upon both the cardboard and the aluminum fluoroscope. It was fairly visible in the former; in the second very intense. Now, the question presents itself, Is there an element of the X-rays in phosphorescent substances, and to what degree may they be employed advantageously?

I wish to acknowledge here many courtesies received from Dr. W. J. Morton in placing at my disposal his powerful X-ray apparatus.

PROF. ELIHU THOMSON ON THE FLUOROSCOPE.

Messrs. Aylsworth & Jackson, of Orange, N. J., makers of the Edison tungstate of calcium fluoroscope, have received the following letter from Prof. Elihu Thomson:

"Gentlemen: I tested your fluoroscope last night, and find it to be a magnificent piece of apparatus. I cannot say too much in praise of it, and, so far as I can judge, your claims as to the efficiency of tungstate of calcium in relation to barium platino-cyanide, are fully borne out in the use of the instrument.

"You are at liberty to use this letter in any way that you may desire, as I feel that it will only be conferring a benefit upon investigators, physicians and others to have at their disposal such an efficient means for examinations by Röntgen rays.

"I will certainly take pleasure in recommending the screen to any one who may desire to use such an instrument."

NEWS CLIPPINGS OF THE EXPOSITION.

The Newspaper Clippings Bureau, 1104-5 Bennett Building, this city, makes in our issue this week the offer to furnish a full set of clippings relative to the exposition, and all that is done there, for the strikingly modest sum of $10. It is also willing for a small sum to include a scrap book and assist in arranging it. We recommend all our friends and readers who want a valuable and interesting memento of the whole occasion to accept the proposition, right now. Nothing is more difficult than to get together such material after the event. In fact, it is impossible to do such a thing; but while the show is going on the Bureau, by its facilities, can get the matter together for immediate delivery or to be held as a collection for the subscriber. The idea is admirable, and the work of the Bureau is such as to enable us to recommend its offer for acceptance.

NEW ADDRESS OF THE OKONITE CO.

The old quarters of the Okonite Company, Limited, in Park Row, are soon to disappear before the march of events, and the company has therefore had to give up offices which they have held so long that they might be said to be a landmark in the downtown electrical trade. The company have now moved to the handsome Postal Building, where they will enjoy facilities in keeping with their own push and enterprise. They will be glad to welcome their hosts of old friends at the new home.

THE COMMERCIAL ELECTRIC COMPANY, of Indianapolis, had their factory destroyed by fire on April 20, but resumed business at once, and were able to fill orders at the end of the week.

Department News Items will be found in advertising pages.

THE
Electrical Engineer.
Vol. XXI. MAY 6, 1896. No. 418.

ELECTRIC LIGHTING.

THE NEW 28th STREET STATION OF THE UNITED ELECTRIC LIGHT AND POWER CO., NEW YORK.

NEW YORK CITY was among the very first to take up electric lighting on a commercial scale and hence it has happened that until comparatively recently it has been able to present but few examples of the very latest practice in electrical central station engineering. During the last few years, however, New York has added to its existing stations others of a character second to none in the completeness of their equipment and the ability exhibited in their design. We need only refer to the Duane street station of the New York Edison Electric Illuminating Company, which will be conceded to be without an equal in the world among its own particular type of station. This station distributes continuous current at 220 volts exclusively. As a contrast to it and by way of a comparison, the delegates and other attendants at the N. E. L. A. Convention will have an opportunity of inspecting what may be fairly considered to be the finest type of alternating station at present existing in the United States. This station was completed only last fall and takes the place of the old station of the United Electric Light and Power Company, at the foot of Twenty-eighth street, close to the East River.

The station as it exists to-day is only of one-half the size and capacity for which it is ultimately intended, and from it is supplied the district between the Battery and Fifty-ninth street. Its location at about the center of distribution of load, together with its close proximity to the water front, would naturally make it a most economical plant; and tests which have already been made, though only preliminary in their nature have shown a remarkable economy of operation over the best records of the older stations.

One of the first considerations in laying out work in a large city where property is so valuable as in New York is economy of space, and in this connection it is worthy of note that in this station 20,000 horse-power of engines, together with the boilers, pumps, heaters, condensing apparatus, dynamos and switchboard, and storage for 6,000 tons of coal, are all on a plot of ground 160 feet 11 inches by 197 feet 6 inches. All machinery, including the boilers, is on the ground floor, and yet there is plenty of light, air, and ample space for working around all the apparatus, both for its ordinary operation and for making repairs.

THE BUILDING.—The building already erected, a view of which is shown in Fig. 1 has a frontage of 160 feet 11 inches, and is a steel frame structure with a brick filling in the walls, except on the north end, which is covered by a corrugated iron curtain wall which will be removed when the Twenty-ninth street side is built. This entire front wall is hollow and is carried up above the roof, to prevent the noise from the machinery annoying the patients in Bellevue Hospital, which is directly across the street. The wall is really composed of two walls, one 12 inches thick on the outside, and one 8 inches thick on the inside, with a 2-inch air space between them. These two walls are bonded together at every sixth course vertically by bricks spaced 20 inches horizontally.

Double windows are also placed on this side of the building, to prevent the noise of the machinery from causing annoyance, and this arrangement has been so successful that, standing directly in front of the building, it is impossible to tell whether or not the machinery is in operation. The foundations for all the machinery rest on solid rock, as do the foundations for the building itself, with the exception of one small corner which has no great weight to carry.

THE BOILERS.—The boilers are of the Morrin upright water-tube type, built by the Clonbrock Steam Boiler Com-

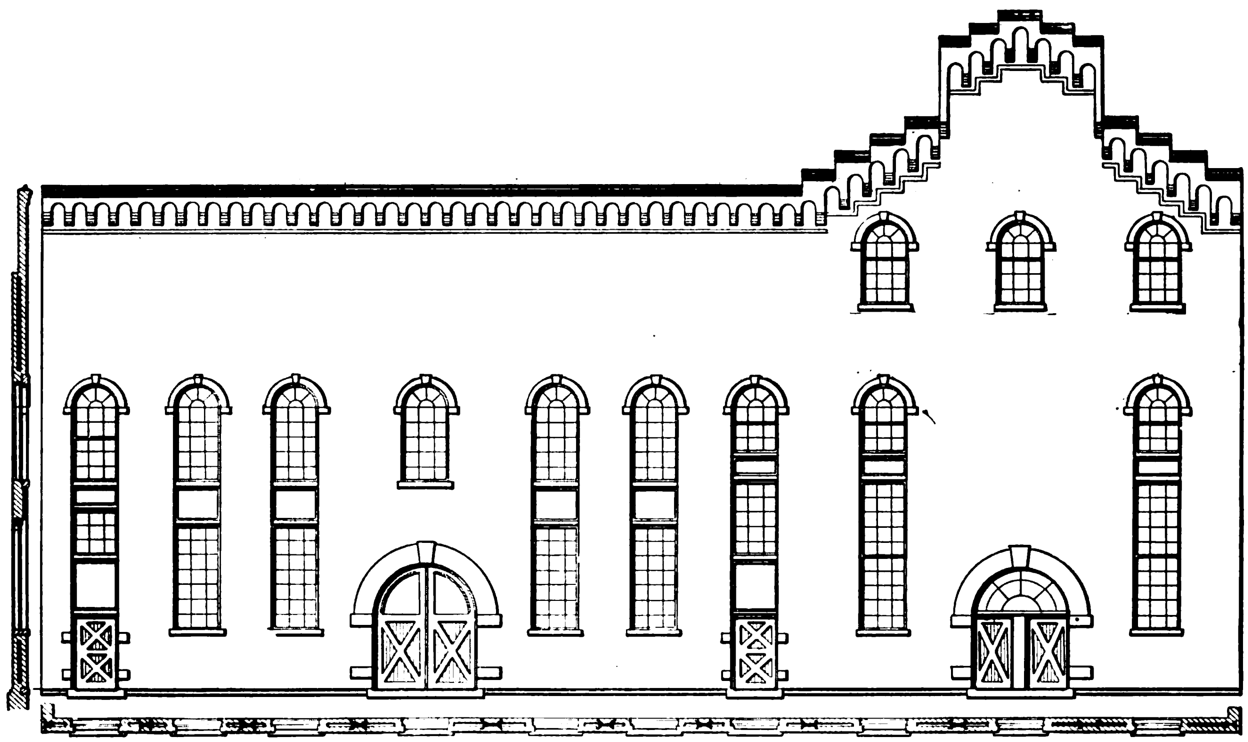


FIG. 1.—UNITED ELECTRIC LIGHT AND POWER CO.'S STATION.—FAÇADE.

pany, and are in 600 horse-power units. Aside from being economical in the generation of steam, they were selected

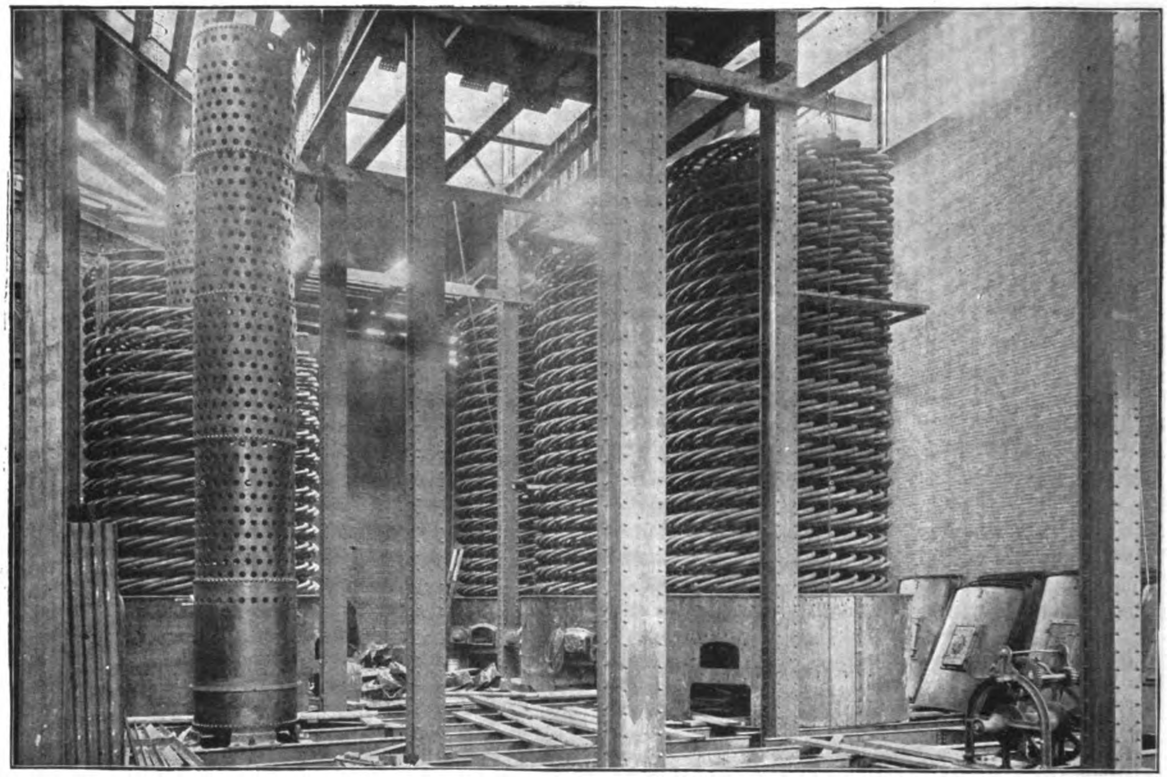


Fig. 2.—United Electric Light and Power Co.'s Station.—Boiler Room.

especially because they occupy so little ground room per unit of capacity. Six are now installed, and six more are required to complete the half of the station now erected. The view in Fig. 2 shows the arrangement of the boilers, as well as their appearance during erection. It will be seen that part of the boilers have all tubes in place, while the shell of one has just been set up, no tubes having been put in it.

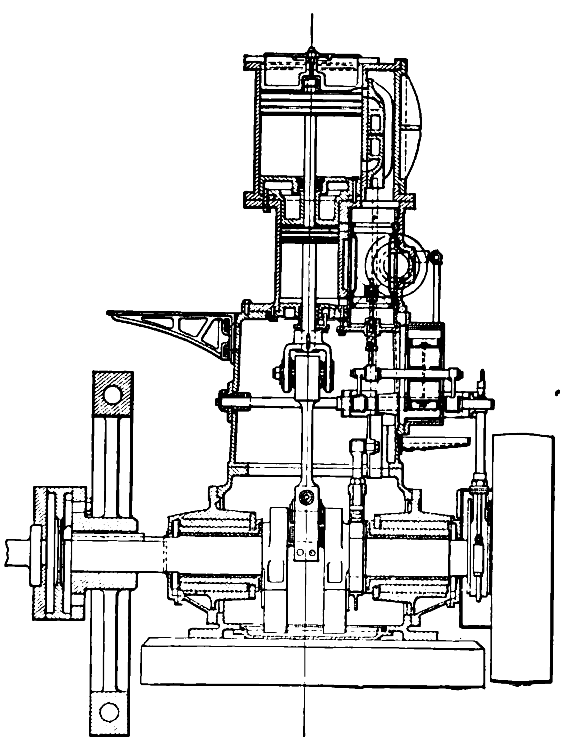


Fig. 3.—Westinghouse Compound Steeple Engine.—Section.

ENGINES.—The engine adopted is a Westinghouse double-acting, known as the "Columbian steepled compound," and is of the same type as those used in the lighting station at the World's Fair at Chicago. In fact, three of the engines at present installed were in service in that station. Fig. 3 shows one of these engines in section. The low-pressure cylinder is placed over the high pressure, and both pistons are connected to the same rod. The crank is inclosed in the same manner as is customary in the more familiar types of Westinghouse engines. The low-pressure valve is operated by a fixed eccentric placed inside the crank case, while the high-pressure valve receives its motion from a shifting eccentric outside the crank case, operated automatically by the governor, which is placed on the shaft outside of the eccentric. The low-presure is of the slide-valve type, while that for the high-pressure cylinder is a hollow piston valve, being constructed in this manner to allow the exhaust from the lower end of the high-pressure cylinder to pass up through it. On account of this construction it is impossible to cushion the valve itself, and this cushioning is accomplished by a plunger, receiving the same motion as the valve, which works in what is termed an inertia cylinder placed outside the crank case, as shown in the cut. This inertia balance is also used for working the engine by hand, the eccentric being first disconnected by throwing over a small hand wheel, and steam being admitted above or below the plunger by means of a small slide valve. The dimensions of these engines are as follows: Diameter high-pressure cylinder, 21½ inches; diameter low-pressure cylinder, 37 inches; stroke, 22 inches. The speed is 200 revolutions per minute and the rated horse-power 1,200 when operating condensing, with 150 pounds initial steam pressure. Fig. 4 shows the four engines and dynamos already installed on the east side of the engine-room.

DYNAMOS.—Each main engine is directly connected to a 600-kilowatt Westinghouse alternator by a rigid coupling, both engine and generator being set on a firm cast-iron bedplate. The generator has but one bearing, the armature being swung between the armature and this single support. Four of these outfits are now erected in place, and four more will be required in the first half of the station. These generators are similar to those used in the lighting station at the World's Fair at Chicago, except that the armatures are wound for 2,500 volts, and are slotted instead of toothed. By this means the noise, which would be objectionable in a thickly populated district, is almost entirely done away with. The alternators are all arranged to give either single or two-phase current. This is accomplished in two of the four machines already in

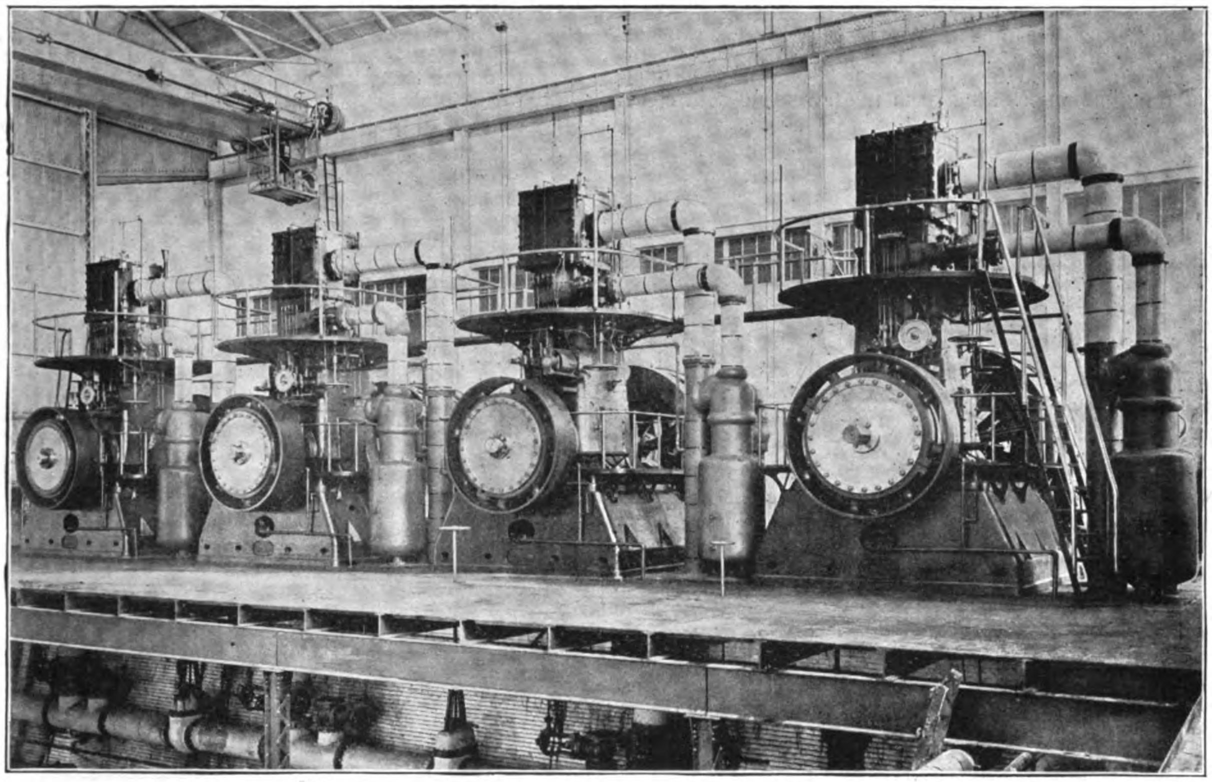


FIG. 4.—UNITED ELECTRIC LIGHT AND POWER CO.'S STATION.—FRONT VIEW OF ENGINES.

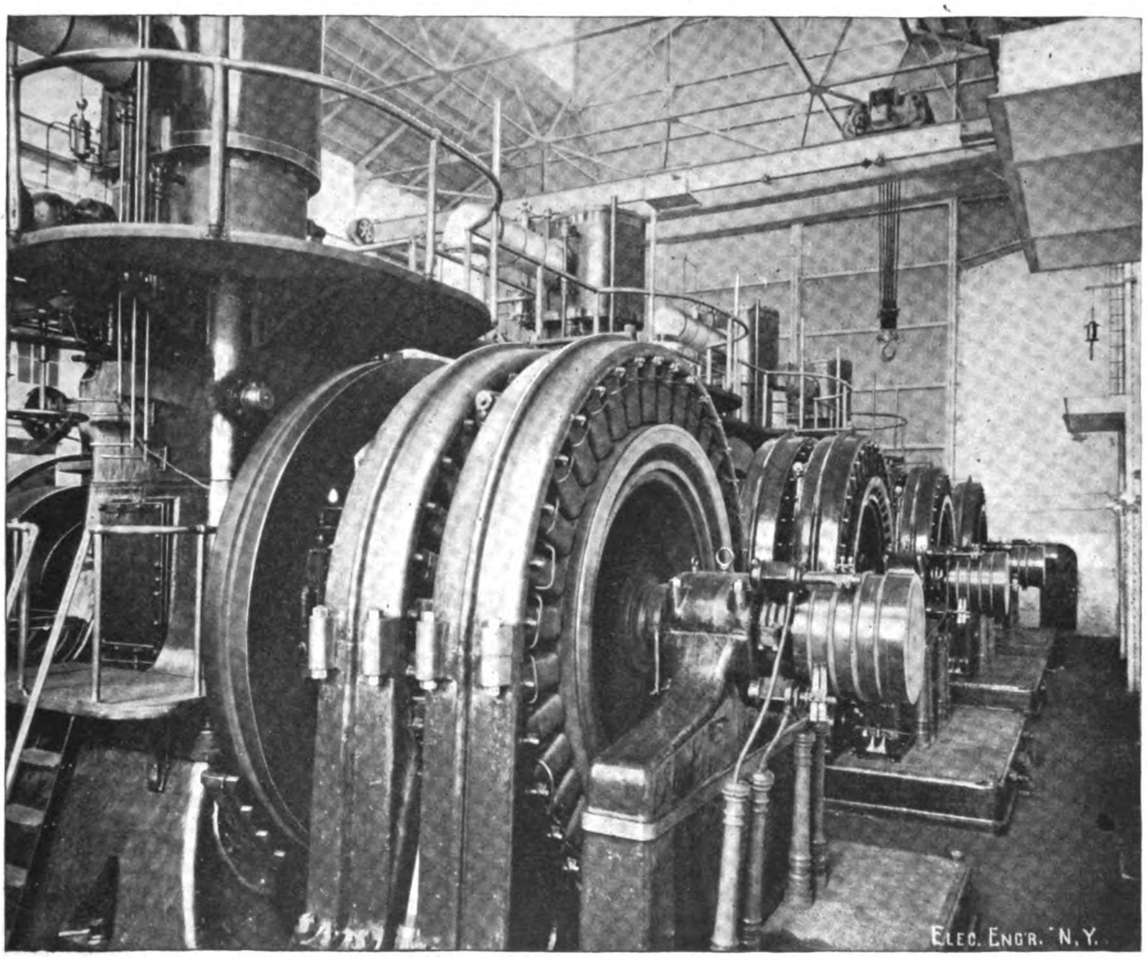
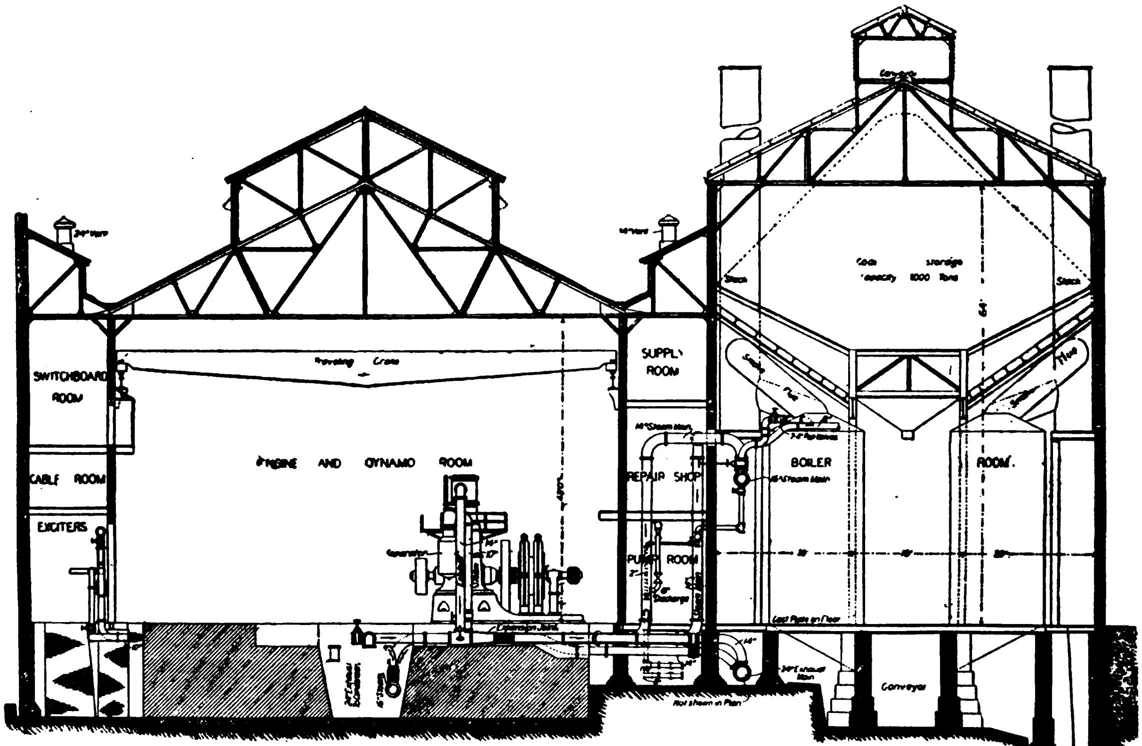


FIG. 5.—UNITED ELECTRIC LIGHT AND POWER CO.'S STATION.—VIEW OF 2-PHASE ALTERNATORS.

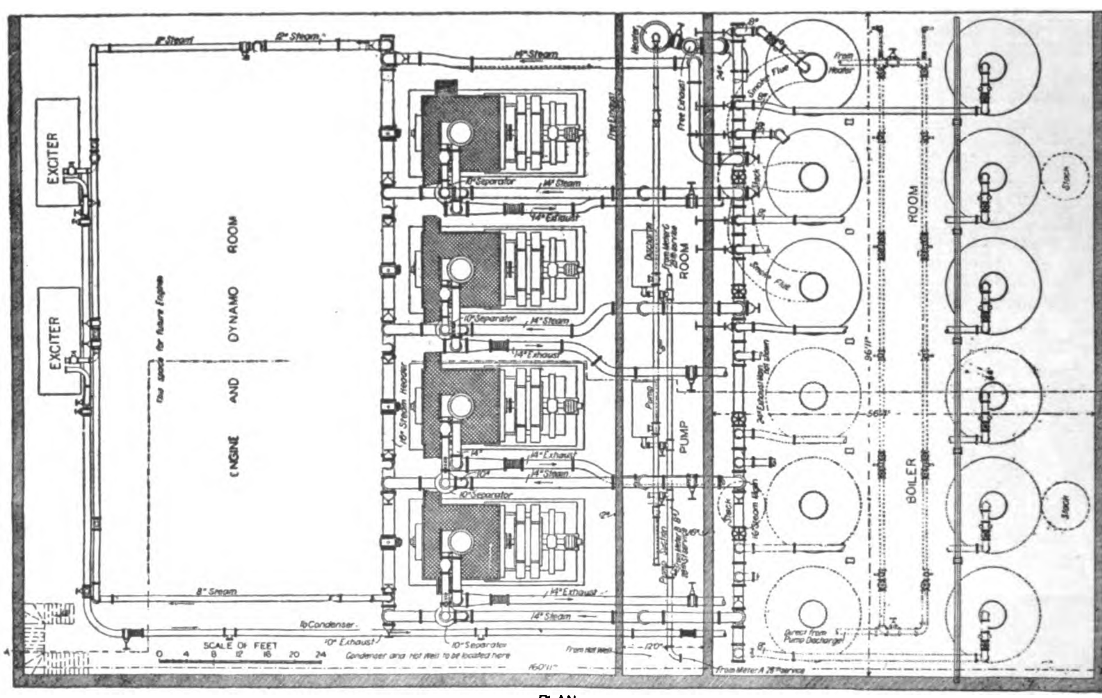
place by two separate armatures on the same shaft, set at the proper angle in relation to each other to give the form of current required. In the remaining two alternators the same result is accomplished with but a single armature. Fig. 5 is a view of the dynamos looking from the Twenty-eighth street side.

street side of the station, and as each has sufficient capacity to excite four alternators, there is always one to spare.

FEED PUMPS.—The feed pumps are arranged in the same manner as the exciters; that is, three are provided, any two of which are able to supply all the boilers in the Twenty-eighth street side of the station at the time of the heaviest load, leaving one spare. These are Worthington compound duplex pumps 9 and 14 by 8 by 10 inches. The steam supply is controlled by a regulating valve operated by the pressure in the feed mains, so that this pressure is always kept constant.



VERTICAL SECTION ON LINE AB OF PLAN



PLAN

FIGS. 6 AND 7.—THE UNITED ELECTRIC LIGHT AND POWER CO.'S STATION, NEW YORK.—SECTIONAL ELEVATION AND PLAN.

EXCITERS.—For exciting the fields of the alternators, 75-kilowatt direct-current Westinghouse dynamos of the railway generator type are used. These are directly connected to 100 horse-power Westinghouse single acting tandem compound engines by means of a flexible coupling. Three of these outfits are provided for the eight alternators in the Twenty-eighth

ELECTRIC CRANE.—The entire engine and dynamo-room is spanned by a Shaw three motor electric crane of 25 tons

capacity. The span from center to center of the rails is 72 feet 3¾ inches, and the crane itself weighs approximately 45 tons. While a crane of this size and character in a power station may appear to some to be in the nature of an extravagance, its use has been fully justified, as it has saved in time and labor more than its cost in setting up the machinery now installed. Moreover, the first cost of the crane is very largely offset by the fact that its presence enabled the roof of the building to be made very light, just heavy enough, in fact, to provide for the wind and snow load, while it would have otherwise been necessary to make every roof truss strong enough to suspend the heaviest part of the engines or dynamos from it, thus materially increasing the cost.

COAL AND ASH CONVEYOR.—The apparatus for handling coal and ashes is indicated in Fig. 6. The conveyor consists of an endless chain of gravity buckets, which are loaded by means of a filler and can be dumped at any desired point. The driver is in the north end of the ventilator over the coal bunker. The coal filler is in a vault under the sidewalk and the coal is dumped into this apparatus through a grating situated at about the street level. After being deposited in the buckets, the coal is carried up into the ventilator over the coal bunker and dumped into any portion of the bunker desired. From the hoppers in the bottom of the bunker, the coal is spouted to the different boilers. The arrangement is such that the coal trims itself and will continue running down the spouts as required and without assistance so long as any remains in the bunker.

When the Twenty-ninth street side of the station is built, a second conveyor running at right angles to the present one will be put in to bring the coal from the water front. As the company does not own the bulkhead on the Twenty-eighth street side, however, it is necessary to cart the coal at the present time.

Under each boiler is an ash hopper delivering the ashes to a second movable filler, which deposits them in the buckets of the conveyor, when it is not used for coal. The conveyor dumps the ashes at a point from which they are spouted over to a tank in the southeast corner of the coal bunker. From this tank they are spouted down and out through the front of the building into carts. By this arrangement the same conveyor handles both the coal and the ashes, and neither is touched by a shovel, except that for the present the coal is fired by hand. This is a temporary arrangement, however, as the boilers are laid out and set with a view to the use of mechanical stokers, which may soon be applied.

FIG. 8.—UNITED ELECTRIC LIGHT AND POWER CO.'S STATION.—VIEW OF EXCITERS AND SWITCH GALLERY.

PIPING.—One feature of this station which is considered of special interest is the arrangement of the piping, which is laid out on what, for want of a better name, the designer has termed the loop system. By this arrangement the size of the pipes required is reduced to a minimum, and without going to the expense of providing a duplicate set of pipes, steam can be shut off of any portion of the system without interfering with more than one engine or its equivalent boiler capacity. As this amount of spare is always carried, it follows that any portion of the steam-piping system can be cut out without interfering with the operation of the station, and the object of a duplicate set of pipes is thus accomplished without the expense of duplicate pipes and without occupying the space required for them.

The main steam and exhaust piping is shown in plan and elevation in Figs. 6 and 7. A 16-inch header is run the length of the boiler-room and a similar header is run the length of the engine-room between the two rows of foundations, and parallel to the boiler-room header. These are the largest live-steam pipes used and there will be none larger, even when the Twenty-ninth street side of the station is complete and the entire 20,000 horse-power is installed. Each of these headers is divided into five sections by means of four gate-valves, located as shown, and each section of the boiler-room header is connected to the corresponding section of the engine-room header by a 14-inch branch rising from the top of one and discharging into the top of the other, a valve being placed on each end where a connection is made to the header. Each boiler has an independent connection to the boiler-room header, supplied with two stop valves, one in the customary position just beyond the safety valves, and the other at the point where the pipe enters the header. This second valve has its stem extended through the wall into the repair shop, so that in case of trouble any boiler may be cut out from a room having no communication with the boiler house.

Each engine on the east side of the engine-room is connected to one of the 14-inch branches previously mentioned, while outlets are left on the engine-room header for connections to the west row of engines as soon as they are placed in position. In case any section of the engine-room header is cut out, one engine connected to this section can be fed directly from the 14-inch branch, leaving only one which cannot be run, and in case any section of the boiler-room header is cut out, no engine need be shut down, as the one connected to the 14-inch branch can be fed back from the engine-room header. One 14-inch branch may at any time be cut out without interfering with

the supply of steam, four of these branches being sufficient to furnish ample steam for all requirements.

The steam pipe for the exciter-engines runs from the north section of the engine-room header around through the exciter-room, and back to the south section of the same header, as shown in Fig. 7. This forms another complete loop, which may be fed from either end in case of trouble with the other, or from both ends in case it becomes necessary to cut out its center.

The steam pipe for the pump-room is arranged in practically the same manner as shown in Fig. 7, except that in this case the loop is fed not only at the two ends but also at three intermediate points, the same as the engine-room loop.

Another special feature of the steam piping of this station is the use of a combined separator and receiver, shown in Fig. 4, as close to each engine as it is possible to place it. This receiver, built by the Goubert Manufacturing Company, contains six times the volume of the high-presure cylinder of the engine, and as the latest cut- off is one-third stroke, it follows that at full load there is at the engine eighteen times the volume of steam required for one stroke. This reservoir prevents the excessive drop in pressure in the pipe when the valve closes, and keeps a practically uniform flow of steam in the pipe in one direction, allowing the use of smaller pipes than would otherwise be required, and doing away almost entirely with the vibration in the pipes caused by the intermittent flow of steam.

All pipes, valves and fittings carrying live steam are made extra heavy to provide for 150 pounds steam pressure, and were tested and made tight under 300 pounds cold-water pressure after being erected in place.

The exhaust piping contains no special features and is clearly shown in Figs. 6 and 7. A second header will be provided for the west row of engines similar to that for the row already in place, and a third header will be provided, running directly to the condenser and connected to all the engines on both sides. Any engine may then be run either condensing or non-condensing.

SWITCHBOARD.—Although provision is made in this station for the switchboard and all the accompanying apparatus, the switchboard room of the old Twenty-ninth street station has thus far been used, as it is advisable to have both boards in close communication while both stations are running and circuits frequently transferred from one station to the other.

The lead wires from the machines consist of lead-armored cables run in iron ducts directly from each dynamo to its panel on the dynamo board. On this board each alternator as well as each exciter has its own panel equipped with the customary appliances, including voltmeter, ammeter, rheostat, fuse blocks, switches, etc. From each panel on this board connection is made to a separate pair of bus-bars on the back and running the length of the feeder board, and here each circuit has a separate panel equipped with a voltmeter, ammeter, continuous registering meters, etc. At a convenient height on each panel is situated a double-pole dynamo change-switch with the circuit leading out from the center and two flexible cables connected to each end. These cables can be plugged in on any pair of bus-bars and a circuit transferred from one dynamo to another by a single throw of the switch. From the center of these switches the circuits run to a third board called the cable terminal board, where, after passing through fuse blocks and a second set of switches used for transferring any circuit from its own panel to a spare panel provided in case it is desirable at any time to cut any feeder panel dead, connection is made to the ends of the cables, which extend down through the floor and out to the subways.

SWITCH GALLERY.—It is intended in due course of time to transfer the entire switching apparatus to the switch gallery, shown in Fig. 8, opposite the dynamos at present installed, and directly above the exciters. This gallery overlooks the entire station and from it all the electrical manipulation will be accomplished with a minimum of labor.

The installation of two-phase alternators was undertaken specially with the object of distributing power, and a number of two-phase motors have already been connected to the circuits.

The entire distribution system is underground, and occupies about 150 miles of ducts. The voltage is reduced to any desired pressure by means of converters placed in convenient locations, usually in vaults under the sidewalk. Continuous registering meters are employed to determine the amount of current consumed; they are of the Shallenberger type.

The station was designed by Mr. H. W. York, C. E., to whom we are indebted for the above details as embodied in a paper read by him before the American Society of Civil Engineers. It presents throughout evidence of the most careful study, and no expenditure has been stinted to make it mechanically and electrically perfect in every detail. We hope at some future time to give the results of some efficiency test when the station shall have reached its proper load.

INFLUENCE OF ROENTGEN RAYS ON THE CONDUCTIVITY OF DIELECTRICS.

At a recent meeting of the Cambridge Philosophical Society, a paper on "The Leakage of Electricity Through Dielectrics Traversed by Röntgen Rays" was read by Professor J. J. Thomson and Mr. J. A. McClelland. This paper contains an account of a series of experiments made with the object of investigating the laws regulating the passage of electricity through dielectrics transmitting Röntgen rays. This phenomenon has been discussed by one of the authors in a paper read before the Philosophical Society on January 27th, and also in one read before the Royal Society on February 13th.

The first experiments relate to the rate of leak through different gases under similar conditions as to pressure and potential gradient. The gases used were hydrogen, ammonia, carbonic acid, air, coal gas, sulphuretted hydrogen, chloroform, chlorine, bromine, iodine, sulphur chloride and mercury vapor. Numbers showing the rate of leakage in these gases relatively to that in air are given. In general, though the rule is not without exceptions, the greater the molecular weight of the gas the more rapid the leakage. In hydrogen the leak was slowest, and in mercury vapor fastest; the rate in the vapor of boiling mercury was about twenty-eight times as fast as hydrogen. The rapid rate in mercury vapor is interesting, for this gas offers great opposition to the passage of an ordinary electric discharge. The rate of leak in the halogens is also very rapid, and a tube containing a charged plate in chlorine gas is a very sensitive and convenient method of measuring the intensity of these rays. The rates of leakage in air at different pressures were investigated; it was found that the rate of leak was lower at a low pressure than at a high one, and was over a considerable range of pressure approximately proportional to the square root of the pressure. The effect of temperature was also investigated, and it was found that through air the rate of leak was lower at a very high temperature than at the temperature of the room, but there was an intermediate temperature at which the rate was a maximum.

The most remarkable thing about this leakage under the influence of these rays is that the rate is almost independent of the potential difference. Thus, when a high potential plate was 5 volts above that of the low, the rate of leak was appreciably greater than when the potential difference was 1 volt, but the rate was no greater when the potential difference was 500 volts than when it was 5.

A series of experiments were made to find how the rate of leakage varied with the distance from the bulb; the bulb was placed behind a metal plate with a hole in it; it was found that in the neighborhood of the phosphorescent glass the reciprocal of the rate of leakage was a linear function of the distance from the phosphorescent patch, but at a greater distance it diminished more rapidly than is indicated by this law. The measurements are not inconsistent with the view that the rate varies inversely as the square of the distance from a place in the neighborhood of the negative electrode. Some experiments on the rate of leakage produced by the rays after passing through a varying number of strips of tinfoil seem to indicate that these rays are not all of one kind.

SPECIFIC HEAT OF ELECTROLYTES.

An interesting investigation on the specific heat of solutions has been given by Herr G. Tammann ("Zeitschrift für Physikalische Chemie"). It is well known that weak solutions of certain electrolytes have a smaller capacity for heat than the water present in them possessed previously to the introduction of the salt, and the object of the investigation is to establish a connection between this phenomenon and the contraction of volume which accompanies the process of solution. This contraction has often been accounted for by the hypothesis of a certain internal molecular pressure. Herr Tammann calculates the specific heat of the water present in a number of solutions of this class on the supposition that their pressure is the increased pressure postulated by the above theory, and he also calculates the specific heat of the dissolved substance, that of the mixture being deduced by adding the thermal capacities of the two components. The theoretical values thus obtained are found to agree closely with the values experimentally found by observing the solutions themselves, and it is inferred that contraction is the sole cause of the diminution of specific heat arising from the presence of the dissolved matter.

THE ELECTRICAL PLANT IN THE SIEGEL-COOPER CO'S. "BIG STORE", NEW YORK CITY.

NEW YORK has of late years seen some remarkably fine buildings erected on its principal thoroughfares, for various uses. As a general thing these architectural additions to the city have been more distinguished for their extreme altitude than for either their beauty or their extent of street front. It is obviously a necessary condition of the dry goods business that the buying public shall be able to roam freely over large floor spaces, where the different groups of articles are displayed to advantage; so that the modern store of this character, even when pretentiously large, does not run up very far into the air, but estimates its importance and magnitude by the number of square feet that it covers. While using extreme care to reach the highest possible efficiency and economy in all devices and apparatus used in such establishments, the managers of these businesses still desire to arrest the attention of the town, and to make their stores the theme of general conversation, and hence they are tempted to try experiments of one kind and another which shall help them fill the public mind and eye while they empty the individual purse. The problem here suggested has been dealt with in a variety of ways, and one of the most notable instances of its solution is found in the building here illustrated—Fig. 1—the "Big Store" of the Siegel Cooper Company.

MR. HARRY ALEXANDER.

This store owes its origin to the enterprise of a firm which has already made its mark in Chicago, and which comes to New York hoping by its experience and its special methods to reap an even richer reward than in the metropolis of the West. One great feature in connection with the building here shown is that special reliance is placed upon the use of electricity, which, while being used for every purpose, including light, heat, power and ventilation, is also utilized as a means of attraction. Probably no other private edifice devoted to trade has ever had such a blaze of light or more ingenious specialties in the nature of advertising display. It will dominate, in a spectacular way, its whole territory, being at the very heart of the uptown shopping district, and its dome will be even more brilliantly outlined against the nightly sky than is the tower of Madison Square Garden.

The building, of which we show a perspective view, is 196 feet 6 inches front on Sixth avenue, extending down West Eighteenth and Nineteenth streets a distance of 460 feet. There are six floors, with a deep basement, a cellar and an extra story for special purposes on the roof. Altogether the floor space available is 611,880 square feet, or over fourteen acres. Rising far above the roof is the tower, which, however, is not for mere ornament, but will have rooms in it, one of which will be Mr. Siegel's private office. The height of the tower is 225 feet, and above that will rise a flagstaff, the tip of which at night will gleam with a 500 candle power incandescent light. The whole front of the building will be brilliantly studded with light, in a manner to be described later, while from the tower, the revolving beam of a searchlight will serve as a constant reminder of the store to a city full of women keen for bargains.

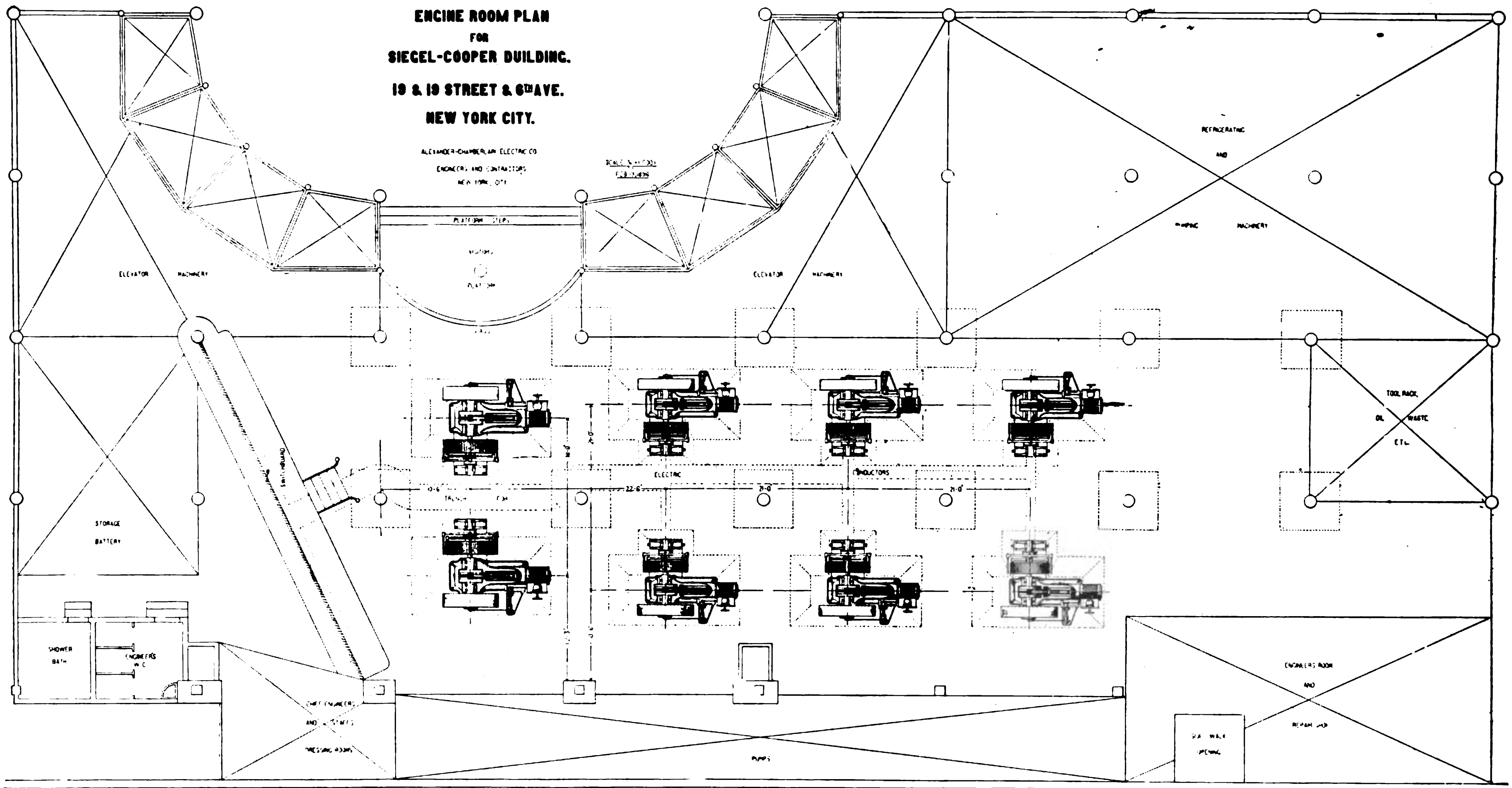
The plans and specifications, including all details of the work described in this article were drawn up by the Alexander-Chamberlain Electric Company, of this city, and were laid out under the direct personal supervision of Mr. Harry Alexander, whose portrait is vignetted at the head of this article, and for which work he acted as designing and consulting and now as contracting engineer.

Although this huge enterprise is a large undertaing, the work has been so well laid out and planned that the Alexander-Chamberlain Electric Company are well in advance of their work despite obstacles constantly confronting them such as change of plans, labor troubles, etc., which are inevitable in a building of this description. They are well equipped at the building with offices, drafting, store rooms and workshop, and with telephones both private for use through the building and connected with the outside world, making it a complete, perfect outfit; only with which work of such magnitude can be carried on successfully.

FIG. 1.—THE NEW SIEGEL-COOPER STORE, NEW YORK.

To begin with the generating plant, Fig. 2, which occupies the southerly wing of the basement and as shown on the plan; this will consist of no fewer than eight units. There will be six smaller units of 100 kilowatts and two larger of 150 kilowatts. These units will consist of Siemens & Halske dynamos, direct connected to Ball & Wood engines.

The engines are of the latest type for direct connected work. Two have cylinders 21 by 16 and are rated at 225 horse-power each. Six have cylinders 17½ by 14 and are rated at 150 horse-power each.



Each engine is equipped with the new Ball & Wood oiling system, gravity feed, dispensing entirely with the use of oil cups, and admitting of close inspection by the engineer while in active service.

The Siemens & Halske dynamos are of the familiar direct connected type, with the outside armature and peripheral commutator, and will provide current for 6,500 incandescent lamps, 3,000 of which are used for display purposes on the front of the building; nearly 800 arc lights, and a large variety of electric motors, besides the motors used for running the electric elevators. Orders have just been given to place a small auxiliary unit to the east of the other equipment already laid out in the diagram shown herewith.

This unit will consist of a 30 kilowatt direct connected multipolar Eddy generator and a Ball & Wood engine. This combination has been set on foundations at once and started to furnish current for various operations connected with the erection of the electrical work. The two large units, representing no less than 450 horse-power, are intended to be used for power purposes, and the battery of six smaller ones is for the electric lighting service, but arrangements have been made in the design of the bus-bars as shown in Fig. 4 for connecting all dynamos together.

FIG. 2.—THE NEW SIEGEL-COOPER STORE.—PLAN OF ENGINE AND DYNAMO ROOM.

In order to operate the "sweeping" lights and for illumination of the windows, dome, searchlight, etc. ,a storage battery consisting of 110 working and 20 c. e. m. f. cells will be installed. The capacity of this battery will be 1,000 ampere hours at a minimum pressure of 1.9 volts per cell. Arrangements will be made for charging and discharging this battery two sets in multiple at 110 volts or two sets in series 220 volts as occasion

may require. It is contemplated using independent plates of low broad form, each plate being arranged so as to be taken out of the cell should it be necessary and replaced by another without disturbing any connections or stopping the operation of the battery.

the marble slabs and also a platform reaching in front and behind the switchboard proper, permitting quick and easy access to connections and switches, while allowing the operator an unobstructed view of the engine room. Leading to this platform is an iron stairway in front and an iron ladder

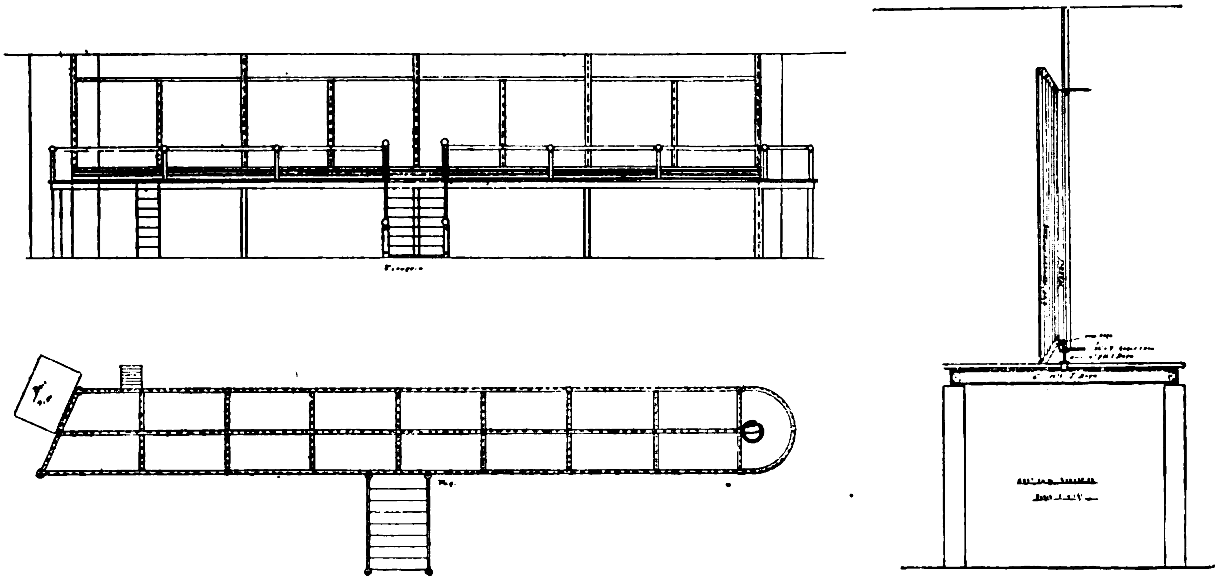


Fig. 3.—The Switchboard, New Siegel-Cooper Store.—Plan, Elevation and Section.

These batteries will be charged from the bus-bars, a booster of from 20 to 30 volts and 250 ampere capacity being placed in the circuit to raise the pressure when charging. This booster will be direct connected to a motor and will be controlled by

behind, both having brass rails which are carried around the board, giving the whole a very handsome and chaste appearance. The framework is now being erected and when in place the marble slabs will be mounted and drilled while in position

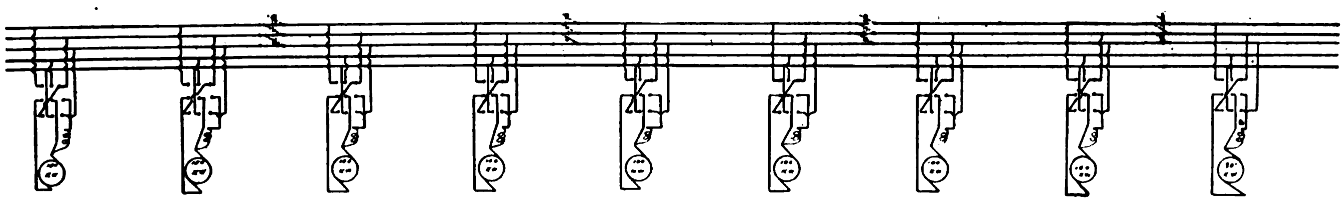


Fig. 4 —The Siegel-Cooper Store.—Method of Dynamo and Bus Bar Connection.

a double-throw switch, which, when thrown one way, will make all necessary connections for charging, and when thrown the other way will allow the batteries to be discharged.

All the circuits will be carried under the dynamo room floor

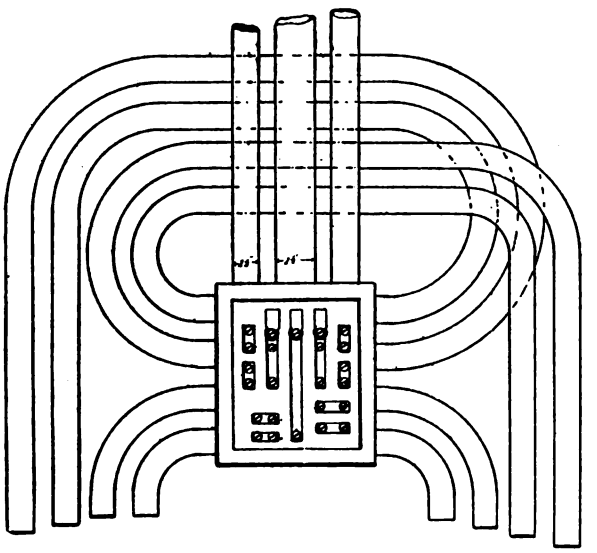


Fig. 5.—The Siegel-Cooper Store.—A Bit of Interior Conduiting.

to a magnificent white Italian marble switchboard nearly fifty feet long, set slantingly as shown in the cut. This switchboard is raised six feet above the floor level on a framework of structural iron similar to the construction used in modern steel buildings. This framework comprises the supports for

by a portable electric drill. Fig. 3 gives a plan, elevation and enlarged section of this framework.

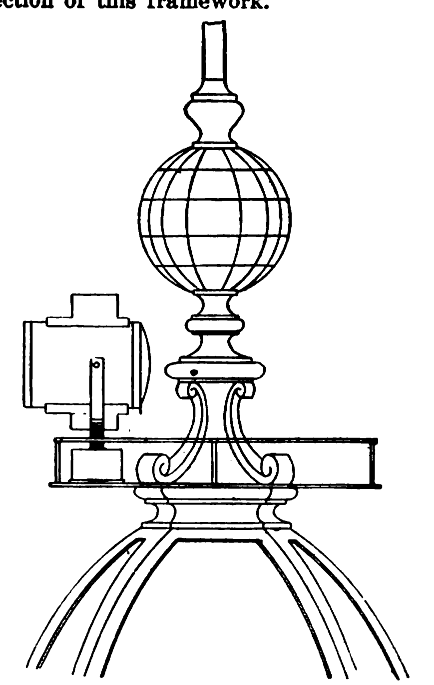


Fig. 8.—The Cupola with the Search Light.

The bus-bars and connections of copper weigh nearly two tons. A diagram of these is shown in Fig. 4.

The instruments mounted on the board are those of the

Weston Electric Instrument Co.'s illuminated dial pattern. There are two ammeters of 1,400 amperes, six of 800, and one of 200, all being of the detached shunt type, and five Weston voltmeters all reading up to 270 volts.

The switches are of a spiral jack-knife pattern. The "backbone" of the arm, so to speak, is made of brass tube slotted to receive a copper blade, held in by special arrangement of plugs and nuts, making a secure

As shown in the section, Fig. 3, the whole switchboard is inclosed in a mahogany frame of 6-inch by 8-inch molding.

It being thought advisable to make this plant one of the show features of the building, a platform is being erected which will allow visitors an unobstructed view of the whole engine room. This platform will be separated from the engine room itself by a plate glass front.

In order to facilitate repairs, should any be necessary, an

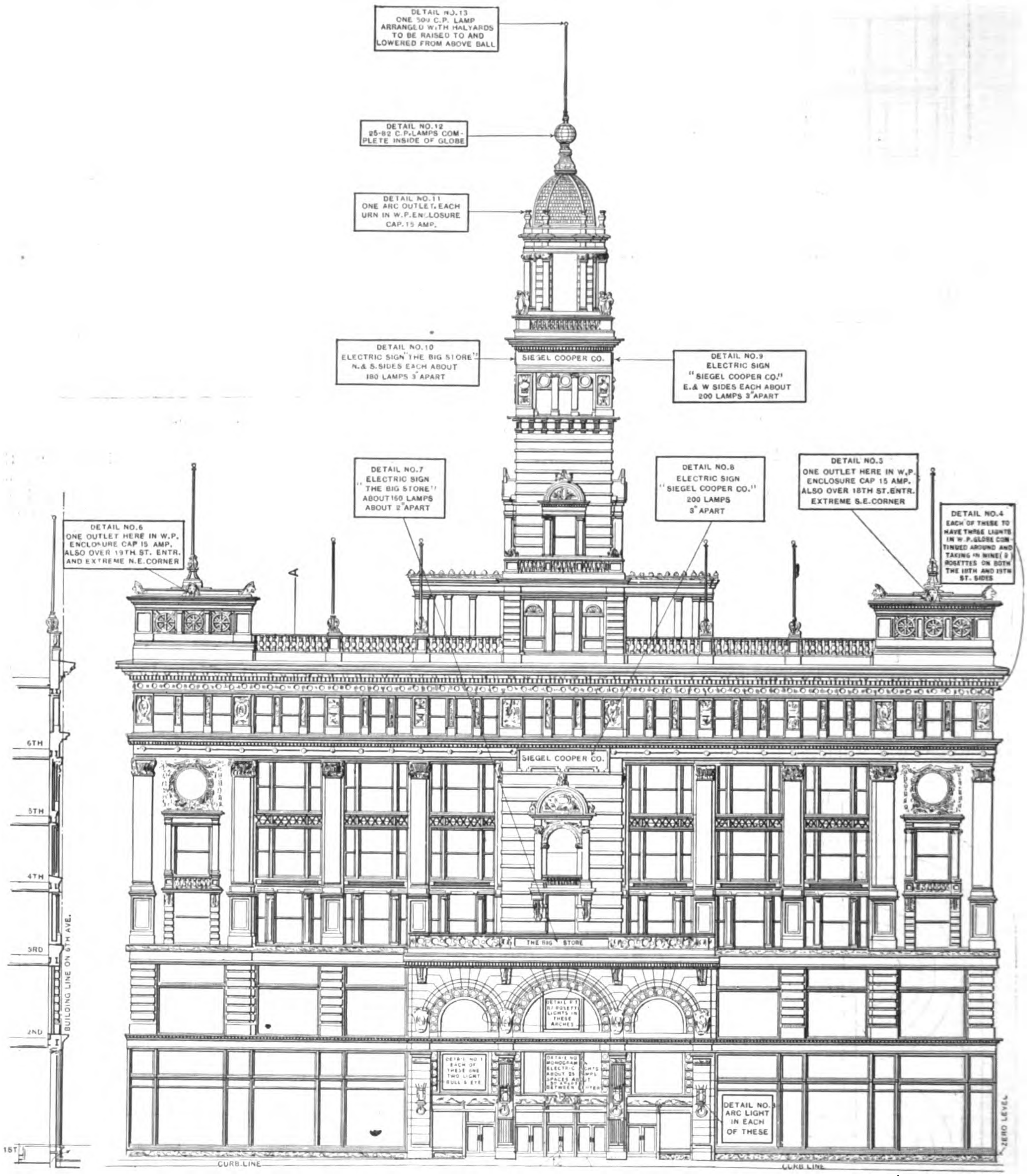


FIG. 6.—THE SIEGEL-COOPER STORE.—FRONT ELEVATION, SHOWING LOCATION OF ELECTRIC SIGNS AND DECORATIONS.

and strong arm, as well as ensuring a good flexible contact for the clips. These switches are being constructed according to the directions of the engineers. There are sixty feeder switches and eight dynamo switches provided, besides those for the voltmeter and field circuits, while provision is being made, as already stated, for connecting another dynamo to the switchboard.

overhead track is being erected. This track will be capable of sustaining a load of five tons, and will be completely equipped with differential pulley blocks, gears and turntables, with ball bearings throughout, one of these latter being located between each pair of units and arranged so that hoists can be run directly over either the engne or dynamo, the damaged part lifted up and carried to the engineers' machine shop, where

the necessary repairs or alterations can be made. This machine shop is to be equipped with all the latest and best apparatus, such as lathes, milling machine, drills, forges, etc., these being operated by a 10 horse-power motor.

Current is distributed to no less than 120 miles of circuit, for which Habirshaw wire, made by the India Rubber and Gutta Percha Insulating Company, is used; for all circuits carrying not more than 100 amperes, duplex cable is run, and owing to the length of the runs some of these cables have to be of 250,000 c. m. area. The conductors range in size from No. 14 to 3,950,000 c. m., all being stranded; these wires are run throughout in "Interior" iron armored conduit, in sizes from ⅝-inch up to and including 3-inch.

The wiring is figured for a 4 per cent. drop from switchboard to the farthest light, allowing 3 per cent. loss on the feeders, 1 per cent. on the mains, and 1 per cent. on the branches, thus having but 1 per cent. variation between any two lamps. Each floor has two sets of feeders, one each on

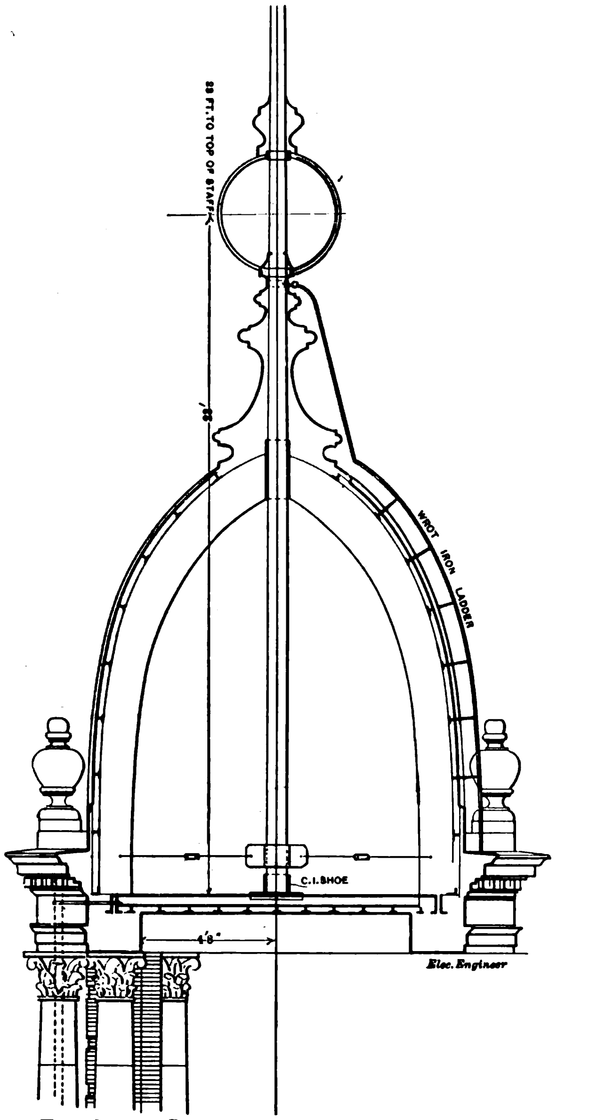


FIG. 7.—THE SIEGEL-COOPER BUILDING.—SECTION OF DOME.

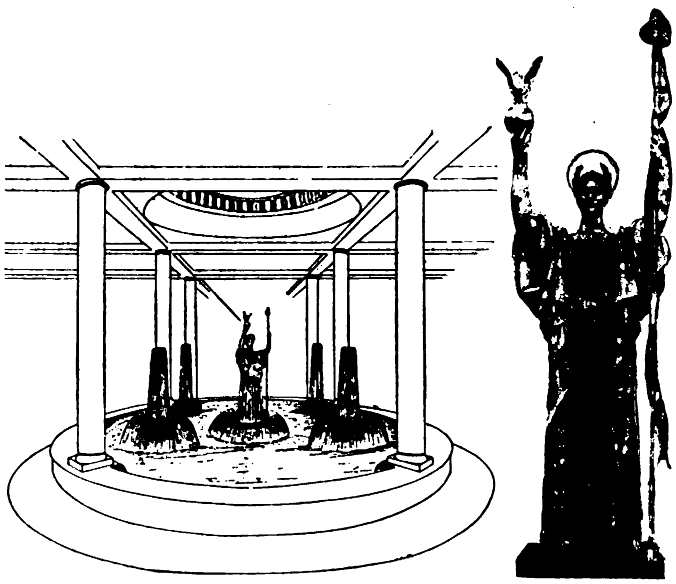
the Eighteenth and Nineteenth street sides, separate feeders being provided for arcs and incandescents. One difficult and unusual piece of conduiting is shown in Fig. 5.

The dynamo feeders are installed for one-quarter of 1 per cent. drop, necessitating wire from 2,225,000 c. m. up to over 4,000,000. They are carried in trenches on porcelain bridges under the dynamo room floor. Each run is of single cable instead of the usual combination of several small ones to get the ampere capacity.

Within the store, as might be expected, the lighting will not only be brilliant, but there will be various special effects. We illustrate herewith a few of the fixtures for the incandescent lighting, Figs. 12, 13 and 14. The arc lamps will be those of the Marks inclosed type, known as the Pioneer, the cases being from designs by the engineers. The selection was made after a very severe competitive test, and each lamp is guaranteed to run 100 hours without new carbons. It will readily be understood that inclosed arcs are peculiarly desirable for the interior of a large store of this character.

The inclosed arcs are of the standard 4½-ampere type. Each of the large ornamental lanterns in front of the building will be furnished with lamps from which the large globe has been removed. When a greater volume of light is desired, the outer globe of these lamps is removed, the light then emanating directly from the small opalescent inclosing bulb. This feature of the lamp makes it especially valuable in show windows, for which it will have extensive use in this building; although there is no outer globe on the lamp it is impossible for any spark or carbon dust to escape from the bulb and injure merchandise below the lamp.

With few exceptions, all indoor lamps for this building will be of special design, the coverings, having been designed to match the other decorations. In the conservatory there will be twenty-six special lamps, provided with green-tinted globes specially adapted for the illumination of this part of the building. In the photograph gallery there will be six special focusing lamps adapted for this particular work. These lamps will be of the type now largely used in the leading universities of the country for stereopticon light and photographic purposes, and will require no lamp mechanism other than a rack rod and thumb screw for their operation.



FIGS. 10 AND 11.—THE ELECTRIC FOUNTAIN AND STATUE OF THE REPUBLIC.

Perhaps one of the most important points in connection with the electrical design of these lamps lies in the perfect regulation of the mechanism throughout the range of the lamp; this regulation permits of successfully operating the lamp through a wide range of voltage, so that if the potential of a circuit varies, even as much as ten per cent., there is no resulting unsteadiness in the light.

Reference has been made above to the lighting in bulk. The cut, Fig. 6, shows in graphic detail just what use will be made of lights on the fronts of the building, while Figs. 7 and 8 give some interesting details of the dome, which is not only a lantern in itself and a support for the lamp-studded flagstaff, but will carry a traveling "search," as shown in Fig. 8, which will be arranged to revolve around the tower, stopping for any desired length of time, with its beam pointing in any direction. This search will be used for signalling election returns and any other matter of general interest, as well as the weather reports and predictions, which will be indicated at night for the day following. It is also intended to project the beam on clouds, etc., and by means of different slides indicate to prospective bargain hunters when a special sale will take place.

At the extreme top of the flagstaff, as mentioned above, will be mounted a 500 c. p. incandescent lamp, which will be arranged to raise and lower by means of halyards.

The sphere shown just below the flagstaff will be built of a framework of iron and diamond cut crystals, inside of which will be mounted incandescent lamps.

Fig. 6 illustrates very clearly the disposition of the various electrical signs around the building and also indicates in minute detail the location of the cluster lights along the cornices

and within the arches of the main entrances. These signs will be constructed in an entirely waterproof manner and all connections and woodwork entering into their construction will be inclosed in a copper casing which will be gilded and highly finished. These signs will be supported on the walls by means of expansion bolts with the connections entering the letters directly form the back. They will thus stand out in bold relief with no unsightly iron work to mar their appearance.

On the first floor, Fig. 9, at the foot of the grand stairway, will be seen, close to the elevator shaft, a space in which will be a superb electric fountain, Fig. 10. This point is practically the center of the store, and visible from every part. It will have a huge basin of marble forty-four feet in diameter. At the center of this basin will stand a replica, in bronze, of French's heroic statue of the Republic, Fig. 11, the same as was seen in the Grand Court of Honor at the World's Fair, rising here to a height of thirteen feet. During the day, when sunshine is flooding the store, the figure will be set off by the spray and by foliage plants, but at night incandescent lamps will twinkle in the dome over the head of the goddess, while from around her feet will burst streams of living color, caused by masked arc lights and moving screens. A preliminary sketch of this fountain is shown in Fig. 10.

The use of electricity for power purposes in this building will be quite notable. Motors are to be applied to a great variety of uses in ventilating, laundry work, machine shop, cash carrier system, etc.

One of the most extensive and varied contracts for elevators, and important as illustrating the rapid advance of the use of electricity in this important service, is that for the elevators. Fig. 9. These elevators have been built by the Sprague Electric Elevator Company of New York City; the size and capacity of some being most unusual. The type of machine which was selected by the engineers for most of the work is that known as type "Z," which is a tandem worm gear drum machine commonly used where large lifts and low speeds are required. The drum is driven by two worm wheels and right and left handed worms with interlocking spur gears. The worm wheels are of bronze, cut by the Hindley method, and are each carried on a bisected machine-cut spur gear. The worm wheels run clear of each other, and the shafts are interlocked by spur gearing. The worms are of steel, right and

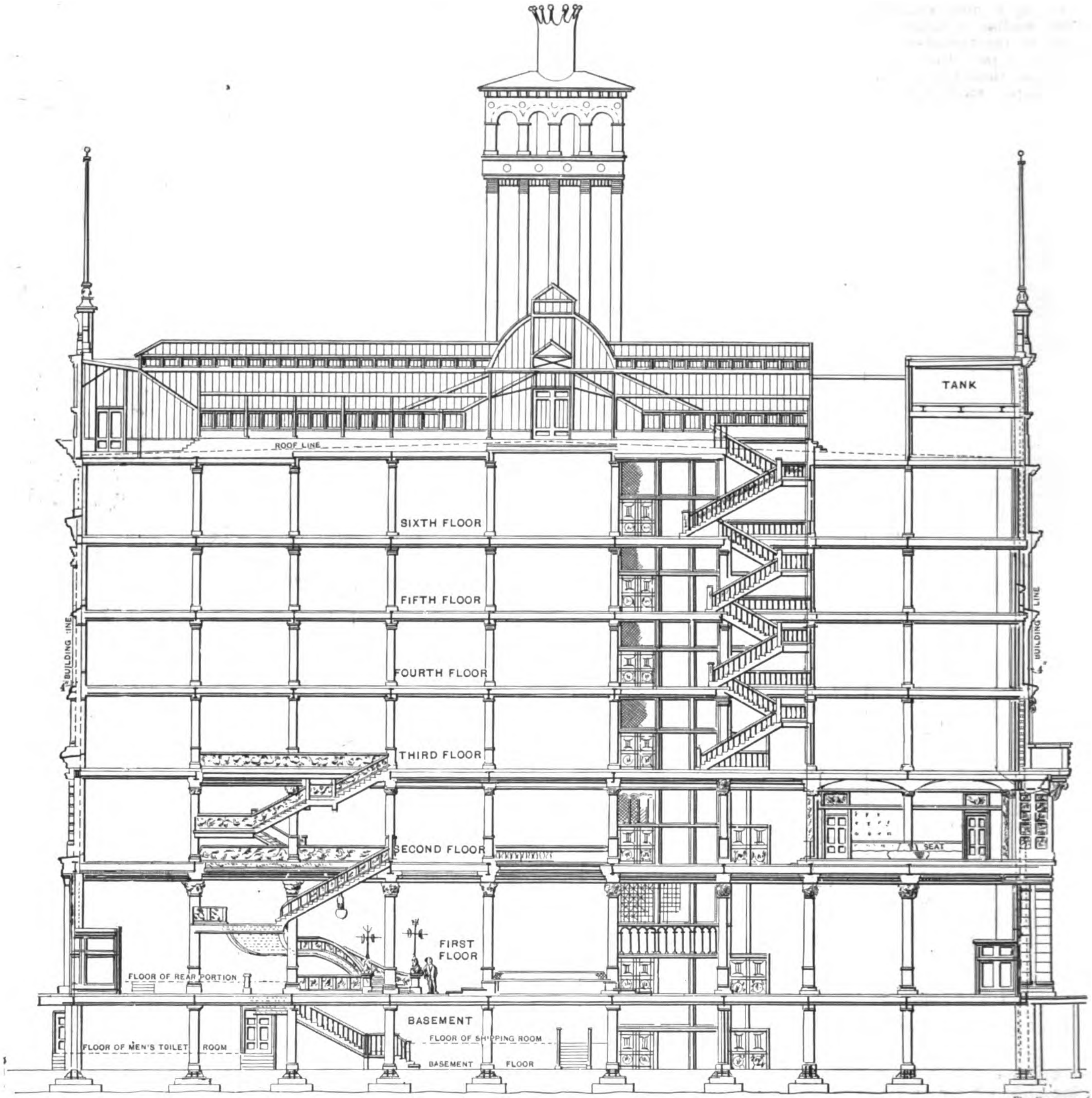


FIG. 9.—THE SIEGEL-COOPER STORE.—SECTION OF BUILDING.

left hand cut, have double pitch and an enormous bearing surface. The worm and spur gears all run in the same gear case and in oil. All the machines are electrically controlled with automatic car controlling switches, and the rheostats are

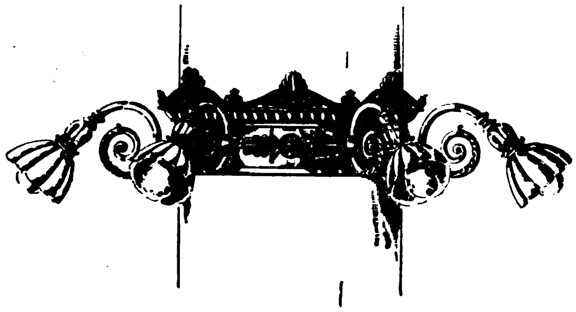


FIG. 12.—A COLUMN BRACKET ELECTROLIER.

operated by pilot motors. The "up" and "down" limit switches are double, the circuit coils being open circuited and on their failure the main circuit operates independently.

The elevator details are as follows: 1. Sidewalk elevator, restaurant platform, 3 feet by 4 feet 6 inches; rise, 13 feet; speed, 60 feet; capacity, 1,200 pounds. 2. Three sidewalk elevators, shipping department to sidewalk, platforms 3 feet 6 inches by 10 feet; rise, 10 feet and 17 feet; speed, 80 feet; capacity, 1,500 pounds. 3. Furniture elevator, basement to sixth floor, platform 12 feet by 16 feet; rise, 95 feet; capacity, 5,500 pounds; speed, 200 feet a minute with 4,000-pound load. Arranged for an additional rise of 30 feet. 4. Three freight elevators, two being from shipping department to sixth floor, rise, 95 feet. One from sub-cellar to roof, 120 feet. Platforms, 10 feet 6 inches by 11 feet; capacity, 5,500 pounds; speed, 200 feet a minute with 4,000-pound load. Arranged for an additional rise of 30 feet each. 5. Two employés' elevators, from first to sixth floor, rise, 86 feet; platforms, 11 feet by 11 feet; lifting capacity, 5,500 pounds; speed, 200 feet a minute with 4,000 pounds. Also arranged for an additional rise. 6. Eight passenger elevators, from basement to sixth floor, rise 100 feet; platforms, 8 feet by 8 feet; speed, 200 feet a minute with 4,000 pounds. 7. Two passenger elevators, from first to sixth floor,

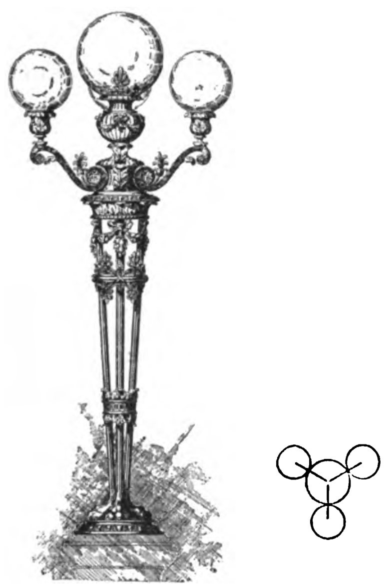


FIG. 13.—A NEWEL POST ELECTROLIER.

rise, 96 feet; platforms, about 5 feet by 6 feet; speed, 250 feet with 2,500 pounds load. 8. One baggage elevator, from basement to sixth floor, platform, 3 feet by 6 feet; speed, 250 feet with 1,200 pounds.

All the motors are self-oiling, and the armature speed is limited to 800 revolutions per minute. The armatures are of the iron clad type. The machines are operated by a special power circuit chiefly at a 240 volts potential.

The building will be equipped with the American Watchman's Clock, and as at present arranged and designed by the engineers, this will consist of a 45-station clock with the necessary dials, etc., connected with key operated stations located through the building in such a manner that the watchman can be made to follow any course desired.

Standard time will be maintained throughout the building by a system of electric clocks, connected to a main regulator located in the principal offices.

The building will be equipped throughout with a fire alarm system indicating on annunciators placed in the engine room and principal offices, and ringing bells located in various parts of each floor. These bells will be arranged to ring for any length of time by regulating an automatic on the engine room annunciator.

Inter-communicating telephones will be arranged and connected so that conversation can be carried on between any points in the building without the use of a central.

A small subsidiary storage battery will be used to furnish current to the watchman's clock, electric time, fire alarm and telephone systems. These systems are of unique design and were carefully laid out by the engineers.

The "Big Store" will also exemplify many other uses of electricity besides those already enumerated above. Electric heaters, for example, are to be employed in the laundry and drying rooms and other places. On the roof there will be a photographic gallery, equipped with the latest pattern focusing lamps, enabling the photographers to go right on regardless of the weather or the hour. Not far away, also on the roof, will be a beautiful conservatory and florist's shop, with all manner of fairyland effects from lamps hidden in flowers and foliage.

The fixtures include about 500 fixtures from one to fifteen lights, and over 1,900 pendant single lights, etc. Many of the larger pieces are very fine. The clusters are to be of the separable type, facilitating the use of 10, 15 and 18 inch porcelain

FIG. 14.—A THREE-LIGHT WALL BRACKET, LADIES' PARLOR.

shades. Some of the styles are shown, as already stated, in Figs. 12, 13 and 14. The newel post fixtures are in rich gilt finish. The column fixtures on the first floor are in Renaissance design, very elaborate and richly gilt.

In the barber shop, café, restaurant, etc., they are slightly less ornate, and silver plated, with the brackets and ceiling fixtures to match. In the ladies' parlor, the Empire style prevails, with all the fixtures heavily gold plated. At the entrance to the building there are solid bronze octagonal glass lanterns of Renaissance design, containing band arc lamps. These are an almost exact reproduction of some famous Italian lantern designs.

Steam for the engines and for heating the building will be obtained from ten boilers of the horizontal return tubular type, 6 feet 6 inches by 18 feet, built by Messrs. Samuel Smith & Son, of Paterson, N. J. The feed-water will be heated by a Berryman heater and filtered by the Ward filter built by Messrs. Ward & Anderson. Some idea of the extent of the steam will be conveyed by the size of the exhaust steam pipe which is 18 inches in diameter. The Locke damper regulator is employed and all steam pipes are covered with the Keasbey sectional covering.

The ventilation of the basement and first floor will be effected by means of eight Sturtevant blowers and exhaust fans, each 8 feet diameter of wheel, and the temperature will be regulated by the Johnson heat regulating system. The conservatory on the roof will be heated by a separate hot water system. The "Big Store" will be opened for business September 1, this year, by which time the plant will have been in operation about one month, and no doubt through the courtesy of the Alexander-Chamberlain Electric Company, the readers of this paper will be given an opportunity to inspect this most interesting and modern plant.

THE WORCESTER AND GLOUCESTER, MASS., CENTRAL STATIONS.

An excellent representative of modern electric lighting and power station practice is to be found in the Worcester Electric Light Company, of Worcester, Mass., where some of the latest ideas in station construction and practice have been put into operation.

The station has been built about one mile from the center of distribution in the town, on the banks of a small stream, which furnishes a supply of water for condensing purposes. The engines are of the Geo. H. Corliss type, having an aggregate of 2,500 horse-power. These are placed on the lower story and are belted to the line shafts in such a manner that any engine can drive any shaft or part of a shaft, as may be required. The belts from the line shafting pulleys pass through the floor to the half story carrying the dynamos, and any belt can be thrown on or off any dynamo pulley at will, the handles being placed beside each dynamo, as shown in the accompanying engraving, Fig. 1.

The arc lighting plant consists of twelve 50-light and four 30-light Thomson-Houston arc machines, each light being rated at 2,000 candle-power. The incandescent plant comprises three 2,000 light and one 1,000 light, 1,000 volt Thomson alternators, while the power portion of the station consists of three G. E. 500 volt multipolar generators, two of 100 kilowatts and one of 200 kilowatts.

The offices and repair shop are located in the second story, the repair shop being arranged to take care of all ordinary repairs on the engines, boilers, shafts, dynamos and lamps.

In the construction of the station the plans of Mr. W. H. Coughlin, the general manager, have been followed out, and the excellence of these and the substantial character of the station will be appreciated from the fact that a lower rate of insurance is charged upon the Worcester station than upon any other electric station in New England.

The lines are at present all overhead, but since last year the company have been laying conduit through the main streets, and during the coming year expect to have the greater portion of their wires in the center of the city placed underground in these conduits. General Electric apparatus is exclusively employed both in the station and streets.

The Worcester Electric Light Company is capitalized at $300,000 stock and bonds. According to the Gas Commissioner's report, the income of the company in 1895 was $136,000, and the operating expenses, $73,000. The net earnings thus show the creditable total of $63,000. The officers are: Thomas M. Rogers, president; H. H. Fairbanks, treasurer; and W. H. Coughlin, general manager; the supervision of the business being in the hands of Messrs. Coughlin and Fairbanks.

Another interesting New England station is that of the Gloucester, Mass., Electric Light Company, rebuilt some six years ago. The present power house is of brick, 100 feet by 50 feet, divided into engine room and boiler room. The building backs on the harbor and has a wharf with docks on each side facilitating the handling of coal. Salt water is used for condensing purposes.

Fig. 1.—The Worcester, Mass., Electric Light Station.

The boiler room contains three horizontal Roberts & Company boilers, each with a capacity of 125 horse-power. The engine and dynamo room, shown in Fig. 2, contains two 250 horse-power McIntosh & Seymour compound condensing high-speed engines, connected to a central shaft so that the dynamos can be operated from either or both engines. The generating plant consists of three 50 light 1,200 c. p. T.-H. arc machines, one 1,300 light T.-H. 1,000 volt alternator, and one 150 kilowatt G. E. monocyclic machine wound for 2,000 volts. In addition to these there are two G. E. 100 kilowatt, 500 volt multipolar generators for power work. The wires from the machines are led to a cage in the monitor room, and are then connected to the different circuits. This method greatly facilitates handling and changes. The switchboard is of the skeleton type readily reached from all sides.

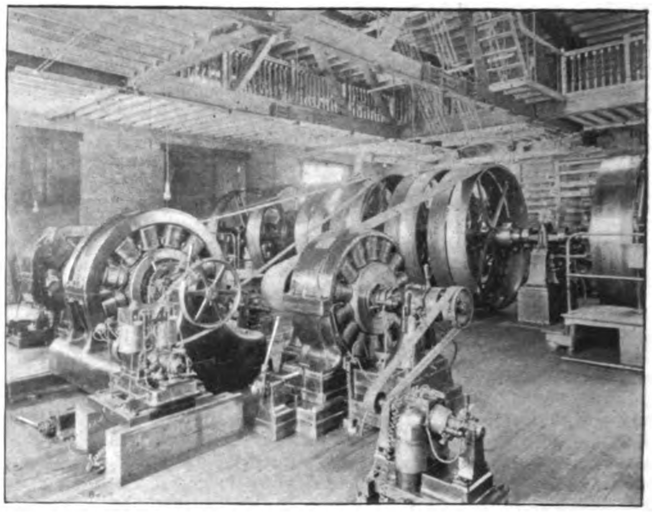


Fig. 2.—The Gloucester, Mass., Electric Light Station.

This company furnishes light and power not only to Gloucester, but also to Magnolia and Rockport. The power demand is very large and the station runs twenty-four hours daily. Magnolia and Rockport are each about five miles distant from Gloucester, and the lights and motors in these two towns draw their supply of current from the monocyclic machine.

The president of the Gloucester Electric Company is Mr. W. H. Jordan, of Boston; E. W. Norris, treasurer; Ernest L. Munger, superintendent and electrician.

FILAMENTS VIBRATING UNDER THE INFLUENCE OF A MAGNET.

LEO DAFT.

In The Electrical Engineer of March 25 there is mentioned an experiment made some weeks previously by Sir David Salomons, in which the filaments of incandescent lamps served by alternating current were made to vibrate, and finally tear themselves from the connections, by gradual introduction to the field of a continuously excited magnet. Since this paragraph has been going the rounds of the papers, I thought it might not be amiss to mention the fact that I used the same experiment in lectures at the Plymouth Congregational Church, Seattle, on the evening of February 13, 1894, and on two other occasions within the month following, during which time it was seen by at least three thousand persons.

I used a magnet with cores 5 inches in diameter, which will support from eight to ten thousand pounds when well excited, and with this the filaments began to vibrate perceptibly at distances of several feet, and were generally torn apart when within eighteen or twenty inches of the poles.

I found it a capital lecture experiment, and when made with a 50 c.-p. lamp was effectively shown to a large audience.

ANOTHER BATTERY STATION FOR BOSTON.

The Edison Electric Illuminating Company, of Boston, has made arrangements for a storage battery plant in the Back Bay, west of Massachusetts avenue. It will be a brick building, considerably larger than its present storage battery plant on Head place, and will be used as an auxiliary to supply the eastern part of the Back Bay district, and will furnish all the current for the western, or newer, part. It will be supplied from surplus current generated at the Head place and Atlantic avenue power stations. This move on the part of the company is interesting as a proof of success of the storage battery system, and contains a hint of how a station may be placed in a residential district without creating the objections of manufacturing directly by the use of steam.

HIGH VOLTAGE LAMPS AND THEIR INFLUENCE IN CENTRAL STATION PRACTICE.—IV.

BY G. L. ADDENBROOKE, M. I. E. E.

I MAY say that Mr. Crompton objects to the method of taking the consumption per 8 c.-p. lamp installed as a basis of comparison, and I quite agree that it is rough and unscientific; and it might be well if our friend the editor of "Lightning" would look into it, and see if he could not get a sounder basis for comparison. Mr. Crompton suggests the relation between the annual output in B. T. units, and the output which would be registered if the maximum load were continued day and night throughout the year. In this case he tells me the actual output would vary from the equivalent of full load for 700 hours in some country towns to 1,000 in parts of London, 1,300 in Kensington, and a much higher figure for the Pall Mall and St. James's Company. Thirteen hundred hours corresponds to a load-factor of 15 per cent.; though it will readily be seen that it is a figure of more comprehensive nature, and not exactly similar. I leave this question here, however, as, though very interesting, to discuss it further now would be out of place in this paper. In order to complete the comparison made above, the cost of insulating and of laying the cables should, of course, be taken into consideration. In order to set this point at rest, Mr. T. O. Callender has kindly prepared for me data deduced from their experience in supplying and laying cables, which, as a result of a large amount of practice, are beyond cavil, and which show the average cost of cables laid as compared with the cost of the copper in them. These particulars are given in the following Table II.:

TABLE II.

TABLE SHOWING THE TOTAL COST OF INSULATED CABLES LAID COMPLETE AS COMPARED WITH THE COST OF THE COPPER CONTAINED.

Character of Cables (Separate).	Armored, laid direct.	Plain, laid in solid bitumen.	Armored, laid direct.	Plain, laid in solid bitumen.
	Sq. inch.	Sq. inch.	Sq. inch.	Sq. inch.
Area of cable: Outer	0.50	0.50	1.00	1.00
Area of cable: Middle	0.25	0.25	0.50	0.50
Area of cable: Outer	0.50	0.50	1.00	1.00
Cost of cable laid complete, exclusive of excavation	19s. per yd., £1,650 per mile.	25s. per yd., £2,200 per mile.	33s. per yd., £2,900 per mile.	42s. per yd., £3,700 per mile.
Excavation, cheap streets and lanes	s. 1 d. 3	s. 1 d. 3	s. 1 d. 3	s. 1 d. 3
Excavation per yard, average run of trench in towns under macadam or pavement	2 0	2 0	2 0	2 0
Ratio of cost of copper (at 7d. per lb.) to cost of complete cable laid, as 1	2.5	3.1	2.2	2.3

Under asphalt or wood the cost of excavation will run up to as much as 15s. per yard run, but this item will practically be the same whatever system is used. Moreover, as only a few of the main streets in large towns are so paved, this item is not one which need concern us particularly in a general comparison, but must be dealt with in accordance with local circumstances in each case. It will be noticed in the above table the middle wire is half the section of the outers; in practice it would not be necessary to have this more than one-fifth for the feeders, and in some cases it might be omitted entirely. The actual cost of feeders should therefore come out about 10 per cent. under the prices given, though I have thought better to leave the table as it was, preserving Mr. Callender's own figures.

At these rates, for a two-mile feeder of armored cable, working at a current density of 250 amperes per square inch, the cost, laid complete, would be about £55 per kilowatt for the maximum output; the fall of pressure being about 10 per cent. I think, therefore, that the whole distributing system—consisting of feeders, branches, local services, service boxes, and every other item, also providing for a fair proportion of the cables being laid under asphalt or wood, from such a station as I have described above, with a service extending 2½ miles in all directions—could be laid complete for £60 per kilowatt.

This is a very moderate figure as compared with the sums now spent. If we assume that 8 per cent. is required to meet interest, upkeep, and depreciation on this outlay, and if we take the output of the station at 800 kilowatt-hours maximum load on the basis suggested by Mr. Crompton, it is evident that interest and upkeep on the distributing system would cost about 1½d. per unit of current sold for the whole distributing system; so that a charge of 1½d. per unit would cover all costs outside the station itself. From what we know of the cost of generating electric energy, it will, I think, thus be clear that, even in places where coal was expensive, a very good profit would be made by selling current at 4d. per unit for lighting, and 2½d. for power purposes. In making this calculation I have assumed the same density of population over the whole area; but it is evident that this would very seldom be the case, as in nearly all towns at two miles from the center the density of population is greatly reduced, which would mean a smaller proportion of long feeders, and consequently a less average cost per kilowatt output than I have taken.

I do not wish it to be assumed from what I have said above that the capital cost of a direct-supply station at 220 volts, with feeders and distributing system extending 2½ miles, as described above, would be as low as that for an alternating station at 2,000 volts, with transformers and 220-volt lamps, to cover the same area. It would not. Comparing feeders, I think, with the present prices of mains, and using the same class of insulation in each case (as is frequently done now)—that is, not using expensive rubber cables for the high tension—the two systems are equal in cost for feeders 1½ miles long. As the distributing system will extend a quarter of a mile further beyond the end of each feeder, a direct-supply station on exactly the same lines is as cheap in capital cost for an area having a base of at least 3½ miles and covering 10 square miles. Further, as something must be allowed to the direct-supply system on account of lower depreciation, and greater safety and freedom from restrictions, and ability to supply motors more easily, another quarter of a mile may easily be allowed on the feeders of the direct-supply station on this account; so that the systems compare together when the base of the area served is four miles and the area itself 16 square miles, even if no accumulators are used.

Although this is not as large as the area I have taken as a basis, what it means can be estimated from what has been said above as to the actual areas covered by large towns. I am, of course, assuming that 220-volt lamps are used on the transformer station as well as the direct. If we assume that the transformer station employs 100-volt lamps, of course the comparison would be much more decidedly in favor of the direct supply at 220 volts.

There is no need, however, to go very minutely into these figures, because, though thoroughly practical, they do not represent what it is clear will be central station practice in the future, as I do not think it probable that any direct-supply station in the future will be operated without accumulators.

The Use of Accumulators.—This brings me to the fifth and last point mentioned at the beginning of my paper when enumerating the possibilities likely to affect central station practice in the future, viz., the use of accumulators. In the earlier part of 1891 I did not see much likelihood of improvements in accumulators making any really fundamental alteration in central station practice. But I must confess that in this respect events moved faster than I anticipated, although I have been brought sufficiently into contact with them to learn what was going on in the field and how batteries were doing as regards upkeep. Up till comparatively recently there is no doubt accumulators have been rather a luxury and convenience in central stations than a commercial or economical necessity; but during the last two or three years considerable changes have been taking place. The maximum safe discharge rate for accumulators has been going up, while the initial cost has been going down, as well as the cost of upkeep, and extended experience holds out the hope of much longer life for the newer and improved forms of positive plates than has hitherto been the rule. Owing also to the method of supplying accumulators at a maintenance rate adopted by the leading firms, an engineer need have less hesitation in recommending clients to incur a large expenditure on them, and the risk is much less than formerly. Patents are also expiring, and considerable competition is arising in this trade, which was formerly such a close one.

I have lately had to make careful inquiries about accumulators in connection with work on which I am engaged, not only as regards prices, but also as to their working, and, having got particulars about the batteries in several central stations, and held conversations with the engineers concerning them, have been considerably surprised at the progress which has been made. Taking quotations from leading makers for a battery suitable for a central station, I find that the capital cost of a battery to discharge at 1 kilowatt for three hours is as nearly as possible £13 for the battery alone. Several makers assure me that such a battery can be discharged at this, and even higher rates, every day regularly, without detriment or endangering the life of the positive plates. The above price does not include buildings to contain the accumulators, connections, instruments, or stands to hold them, which bring up the cost to about £19 per kilowatt on this basis for central station batteries. The makers tell me further that they are willing to enter into contracts to maintain such batteries in a state equal to new for about 6 per cent. per annum on their capital cost, and

some makers will even go lower than this. It will be found that these costs and rates of renewal are a great improvement on those ruling until comparatively recently.

Now I should not quote these figures unless I had, by private inquiries and in other ways, fairly convinced myself of their substantial accuracy. Granting that they are so, it appears to me that they raise questions of very serious import in central station practice, particularly when coupled with the use of higher voltage lamps. If an accumulator will give a discharge for three hours—that is, sufficient to cover the period of heavy load, or the time during which the large portion of the plant has to be kept running—a kilowatt capacity of accumulators will be equivalent to a kilowatt capacity in engines and dynamos. In continuous-current stations, when an increase of output is required—which is from time to time the position of most stations—we are therefore brought face to face with this problem. Extra plant for 200 kilowatts output, say, is required. Which is the best way of providing for it—by adding engines and boilers, or by adding accumulators and charging them during off hours from the existing plant? Now, as I have said above, an accumulator for an extra kilowatt output will cost about £19 complete and erected, including buildings; and I think engineers will generally agree with me that engines, boilers, dynamos and steam pipes for a kilowatt output, including buildings and all other accessories, would cost about the same sum; if foundations, flues, chimney stack and everything else were considered, the comparison would be slightly in favor of accumulators. However, for our present purpose, let us assume that they are equal. We have therefore arrived at the position that the capital cost will be equal, whether we provide extra plant or extra accumulators for the increased output required, charging the accumulators from the existing plant. As regards upkeep, if we can keep the accumulators in an efficient state for 6 per cent. on their cost, this is not greatly in excess of what would have to be allowed on plant if boilers are included; and, at any rate, the difference is not a matter of very great moment.

There is no need to say anything here on the extremely low cost at which energy can be produced if a continuous load is provided night and day. Considering the advantages accumulators give in a central station in providing for emergencies, reducing staff, and keeping the pressure even, it is, I think, doubtful if an engineer placed in the position indicated above—as many engineers will be placed shortly—would not be wise in recommending his corporation or his board to install accumulators for 200 kilowatts output for three hours, instead of the extra plant, when the plant was a continuous one. How far this should proceed is a moot point, dependent upon circumstances, which would need decision in each case. Possibly somewhere about one-third the maximum full-load capacity would be about right now, but with a load-factor of 10 to 15—which is about that general in central stations—if the price of accumulators came down per kilowatt output, which I think it is likely to do in the future, or their efficiency increased, it might be found desirable to install accumulators for as much as two-thirds, or even three-fourths, of the full load, which would place electric distribution nearly on a par with gas distribution in respect to storage. To go as far as that is, however, not a question of the present—at any rate in most cases—and therefore for our purpose this evening I propose to consider the accumulators as desirable for about one-third to one-half the full output.

THE GAS ENGINE AND ITS ELECTRICAL APPLICATIONS.

IN the above entitled paper read by Mr. Charles Macdonald, M. E., before the Chicago Electrical Association, the gas engine of the future was defined as one so designed that its gases could be expanded down to atmospheric pressure. More of the heat that is lost through the walls of the cylinder and out through the exhaust port should be utilized. In governing the engine, the gas and air should be reduced in the proper proportion so as to make always a combustible mixture. The engine should be designed so that its motion can be reversed. It should also be made single and double acting. The gas producing apparatus should be developed so as to have a cheaper gas.

Mr. Macdonald showed that the further introduction of the gas engine depends very greatly on the development of the gas producing apparatus, which of late has made some advances. Heretofore illuminating gas has always been used. The vogue of producer gas has been retarded by its inferiority to illuminating gas in heating power, and its objectionable tendency to gum the cylinder. The single cycle gas engine is showing up, and has already come into public use. While it has many advantages, it has a very low economy. This is due to the charge being too greatly adulterated with burned and inert gases, or to the loss of gas by its following the burned gases out through the exhaust port when too much air and gas are allowed to enter the cylinder. This was well demonstrated in the motocycle tests recently made in Chicago.

Mr. Macdonald held that it was only a matter of time when the mechanical difficulties in the gas engine would be overcome, its efficiency greatly increased and its mechanism made as perfect as that of the steam engine. High smokestacks and boilers would then be relegated to the background, the firebox would be converted into a motor cylinder and the city population would no longer breathe air contaminated by smoke. The cost of production and transmission of power would be reduced to a minimum; the lower strata of society would participate more in the luxuries of life and civilization will have taken another gigantic stride.

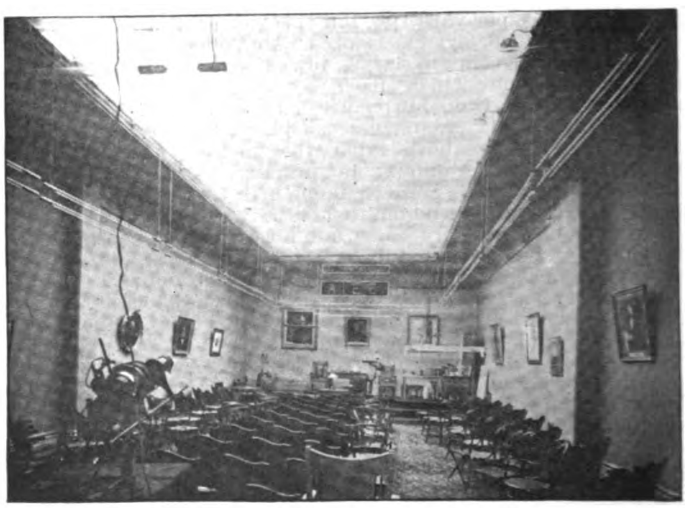
THE FIRST HALL LIGHTED BY VACUUM TUBES.

THE paper read by Mr. D. McFarlan Moore before the American Institute of Electrical Engineers has attracted general attention and the figures as to the economy of the lighting, which we published in our last issue, have come as a revelation to electrical engineers, who were hardly prepared for the statement that a vacuum tube giving light enough to read by required no more energy than a 4-watt sixteen candle power incandescent lamp.

D. McFARLAN MOORE.

It is difficult, of course, to convey to those who were not fortunate enough to be present, an idea of the volume of illumination produced by Mr. Moore's twenty-seven vacuum tubes on the evening of his paper, but perhaps the best evidence we could offer is the photograph of the institute meeting hall, which we reproduce on the opposite page, and which was taken with an exposure of only five minutes by the light of the Moore vacuum tubes. A good photograph was also obtained by a 30-second exposure, while a three-minute exposure gave quite as good a result as the one we illustrate. The sign A. I. E. E., suspended above the platform, was illuminated during only one minute of the five-minute exposure.

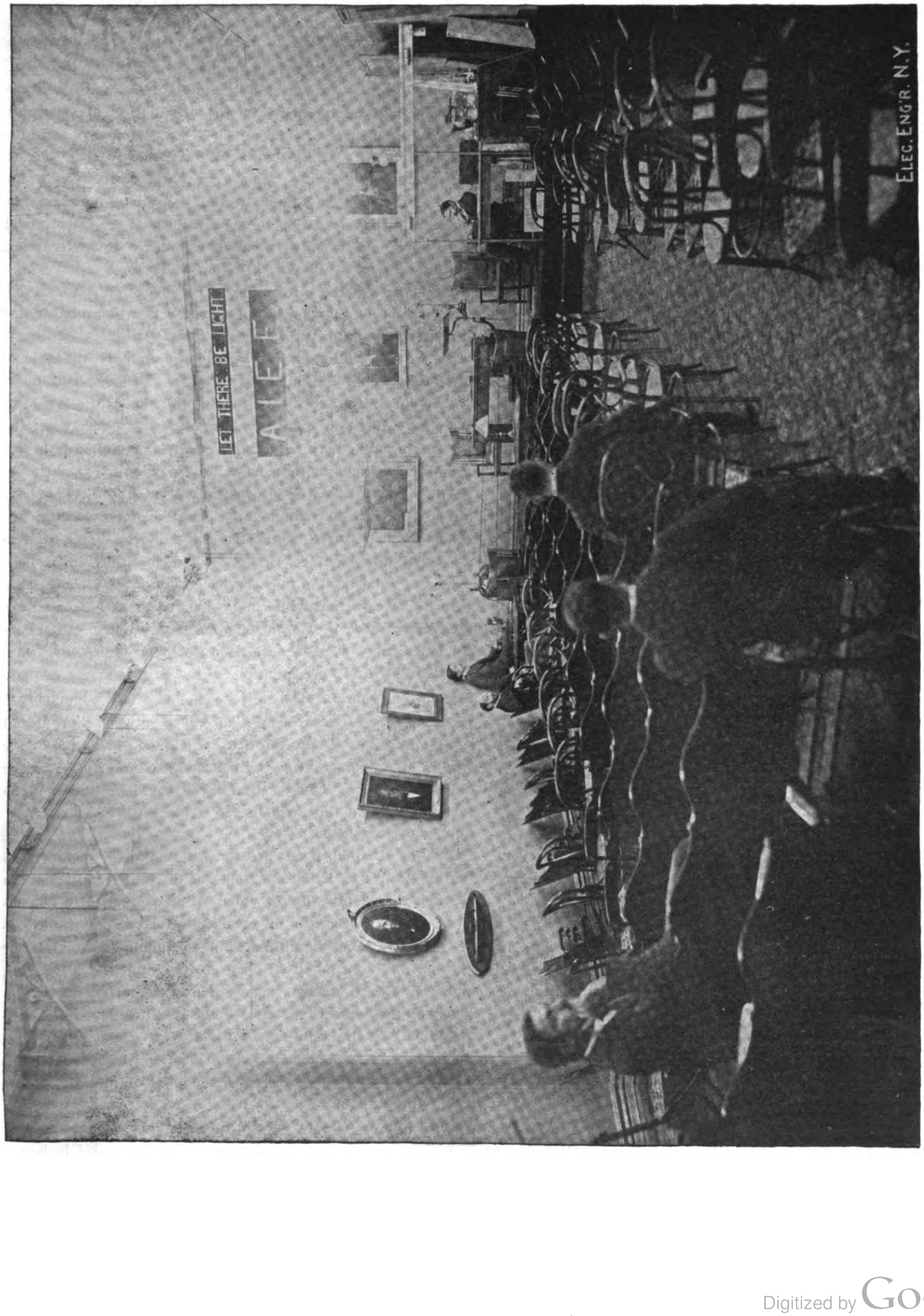
The detail and even tone of the photograph leave nothing to



THE A. I. E. E. MEETING HALL WITH MOORE'S VACUUM TUBES. DAYLIGHT PICTURE, SHOWING ARRANGEMENT OF TUBES.

be desired, and no better evidence could be submitted as to the volume of light present. The photograph, it need scarcely be said, has not been retouched in the slightest degree.

In order to indicate the exact arrangement of the tubes, we reproduce on this page a daylight picture of the meeting hall.



LECTURE HALL OF THE AMER. INST. OF ELECTRICAL ENGINEERS, PHOTOGRAPHED BY MOORE VACUUM TUBE LIGHT. UNRETOUCHED NEGATIVE. EXPOSURE FIVE MINUTES.

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CONTENTS.

CONVENTION TOPICS.

THE Convention of the National Electric Light Association, assembling as we go to press, will probably be the largest in point of numbers and the most representative in character thus far brought together in the history of the association. The exposition will, of course, do much to attract the members of the association, but we hope that they may find time to devote adequate attention to the papers which are to be read at the convention, some of which merit the most earnest consideration of all interested in the distribution of electricity. The continuance of the exposition for an extended period after the convention is an improvement, of course, over the temporary exhibits which have for a long time formed a feature of these gatherings, and ought to afford members no excuse for neglecting the convention in order to inspect the latest novelties which are usually spread before them by enterprising manufacturers.

The papers of the convention will well bear discussion, but there are other things which the members will probably find it advantageous to dwell upon as topical subjects. To begin with, we believe that an interchange of opinion on the inclosed arc lamp would be eminently timely. This type of lamp, which was first practically shown in operation at the Washington Convention two years ago, is gradually but surely gaining its way in public favor, and those who have not already looked into its workings with a view to its adoption ought to be able to gather valuable information from those who have already taken it up commercially. That the inclosed lamp has come to stay there cannot be the slightest doubt, and in Brooklyn, for instance, where 350 such lamps have been employed in street lighting service, a saving of $15 per lamp per year is reported, while in Boston, where 200 inclosed arc lamps have been in use, burning on an average of 3.64 hours per lamp a day, the Boston Edison Company figure out a saving of from $11 to $12 per lamp per year. In these days of close competition and so-called anti-monopolistic city councils, $15 per lamp per year may mean a difference between a profit and dead loss. To be sure there are still some difficulties in the way of the application of the inclosed arc lamp to series arc circuits, but we believe that even these in time will be removed, so that they will largely replace the open arc, now universally employed.

Perhaps of equal, if not greater, interest to the members as the inclosed arc lamp as a topic of discussion will be the Moore vacuum tube light, which will be practically demonstrated by Mr. Moore in an evening lecture. That the incandescent lamp is not the ultima Thule of illuminants for interior lighting has been admitted by even its staunchest advocates, and it would be strange indeed, if a device of such low efficiency as the present type of even the best incandescent lamps would satisfy the ambition of the inventive and resourceful electrician. The vacuum tube light has long been looked forward to as a solution of the efficiency problem, and Mr. Moore has, without doubt, carried it to a point far beyond that reached by any other worker in this field. If, after but a few months of experimentation, Mr. Moore has succeeded in bringing his lamps up to an efficiency close within the range of that of incandescent lighting, what may we not expect in the next few months? That Mr. Moore's tubes give light, will, we think, no longer be denied after an inspection of the photograph which

we reproduce on another page. It will bear comparison with the best interior, artificially illuminated, which has yet come under our notice. No member of the association can afford to ignore this latest advance in the art, which he may be called upon to apply to his circuits at no very distant day.

At several previous conventions members have given their experiences as to outlets of various kinds for station current. It would be more than rash to say that even the regular applications of heat, light and power had by any means been exhausted as long as the load diagrams of most stations still exhibit the undeniable indications of light load. How to even the load, therefore, may well occupy the convention for a brief space of time. Of course the storage battery is, par excellence, the leveler of load diagrams, and will doubtless find more willing patrons among American central station managers as time passes. But what the live manager is after is some paying load to fill the present gap. We know of no better outlet in this direction for spare current than in the generation of electrical disinfectants on a large scale for the purification of city water supply, or the disinfection of sewerage. Enough has been done to demonstrate the thorough practicability of this method of treatment for these sanitary purposes and the members present at the convention may convince themselves of the efficacy of the plan by a visit to the Woolf live exhibit at the exposition.

We might continue in the same strain, but enough has been said, we believe, to indicate that the attendant at the convention who does not get his money's worth out of it will have only himself to blame.

THE STORAGE BATTERY.

ONE of the features of the electrical exposition will be the operation during a certain brief period each evening of a model of the great Niagara power house and hydraulic tunnel, with current energy derived by wire from the Niagara power house. During the periods when the wires are not available, storage batteries charged at Niagara, will furnish the necessary current. Some may regard these demonstrations as frivolous or spectacular, but granted that they are they still serve to emphasize the means which the electrical engineer has at his command for carrying out a given problem. It will serve to bring prominently before the public the fact, first, that power can be distributed by electricity with a facility and flexibilitynot approached by any other form of energy, while it will help to impress upon central station managers the fact that the storage battery is a large and growing factor in their field of work, and that sooner or later it will have to be given serious consideration, whether the station operate continuous or alternating current. In either case the load is a variable one and if we are to be at all guided by foreign experience, the storage battery is the immediately available means for securing the highest economy in operation. In a paper read by Mr. Charles Blizard, before the Henry Electrical Club, New York, that gentleman quoted one of the officers of the Tudor Company as the authority for the statement that that company's eight years' experience in German central station practice indicated that the use of storage batteries insured a reduction of 33⅓ per cent. in the engine and boiler capacity and a saving of from 20 to 50 per cent. in the coal consumption of a station. Making all due allowances for this statement as coming from an interested party, the fact remains that in October, 1895, there were 139 central stations in Germany delivering continuous current only, of which 101, or 73 per cent., were equipped with storage batteries. Throughout the continent of Europe and in England the storage battery has been applied with good effect, supplementing the judgment of German electrical engineers. We are glad to believe that our own central station men are evincing an increasing desire to know more about this type of station equipment. The Boston Edison Company was the first to take up the subject on a large scale, and now with the New York, the Brooklyn and the Hartford companies equipping in rapid succession, it seems that it cannot be long before a wave will pass over the country, the crest of which will land a storage battery in nearly every central station in its path.

LIFE IN THE OLD DOG YET.

IT is certain that the electrical exposition will demonstrate one thing, namely, the extreme liveliness of electrical industries after a prolonged period of dullness, deadness and disaster. Few branches of business suffered more cruelly than did the electrical in the grim panic of 1893, and what with low prices, failures and attempts at monopoly since then, it would seem that very little might have been left as a basis for hope and further endeavor. Yet no one can look around the exposition and fail to realize that the whole industry is full of briskness and brightness, fuller than ever of variety and new departures. It is surprising that doubt as to recovery should have been entertained, but when the road of recuperation is so long to travel, even the more sanguine grow weary.

We do not hesitate to say that the older arts are more solid and stable than ever, while new arts and wider developments are cropping up with a celerity and vigor equaling those of any other period electricity has ever seen.

Above all, it is interesting to look around and see how numerous are the young men who have faith in the future of electricity and crowd its ranks. We believe they will find plenty of room, with golden opportunities for work and reputation as well as for solid financial results. Moreover, the public, as it crowds into the exposition hall, will discover a miscellaneity of invention and application that it probably never dreamed of, and it will see that the end in electricity has not been reached.

NIAGARA IN NEW YORK.

CERTAINLY not the least interesting feature of a remarkably fine show will be the vivid presentation here of Niagara, in the manner that has already been noted in advance in these columns. Around the little model of the power plant of the Niagara Falls Power Company and of the city of Niagara Falls, have been massed a variety of methods, all of which must impress people with the resources of the electrical age we live in. The roar of the Falls is brought to the spot by the long distance wires of the American Tel. and Tel. Company. During most hours of the day the model is run by batteries stored at the Falls plant, and at night live current is delivered by two ordinary Western Union wires, whose run is not less than 465 miles. The tests of this, made successfully on Sunday night, show that some interesting facts will be reached by this demonstration, intended though it be merely as a pretty "tour de force." As a transmission to drive motors it most assuredly distances by far all previous records, and it is not the least striking detail that it is being done, up to the present time, with circuits having iron wire as well as copper in them protected only by telegraph insulation and running through offices and underground cables miles long.

Power Transmission.

TYLER'S SINGLE PHASE ALTERNATING MOTORS AND UNDERGROUND ELECTRIC RAILWAY SYSTEM.

A CONTINUOUS current motor may by alternating current start a single-phase alternating motor to synchronism, but it is quite a different matter to subsequently provide exciting-current for the alternating-motor field during synchronism. In order to accomplish this by the same auxiliary motor which is used for starting, as has heretofore been proposed, it is necessary to place two coils upon the fields of the starting-motor because the coils wound to suitable resistance for the starting alternating current will not be of proper length or cross-section for the succeeding continuous current

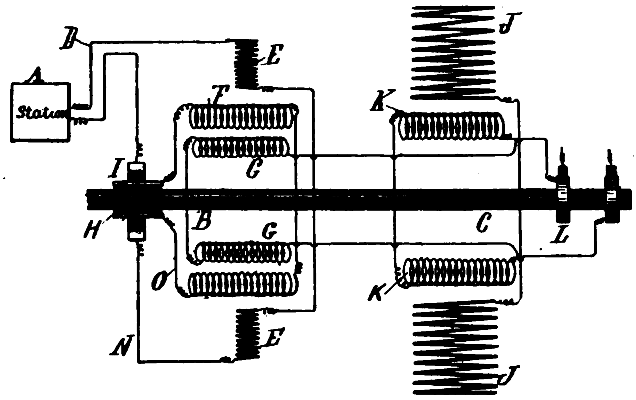


FIG. 1.—THE TYLER ALMERNATING MOTOR.

which must surround the same fields when the auxiliary motor is, as a dynamo, furnishing continuous exciting-current for the synchronous alternating motor. But this method is not practicable , as the two coils on the same field will be in inductive relation, and the transformer action occurring while the starting-coils are used is sufficient to generate a current in the idle coils of such high tension as to destroy them if open-circuited, while it is not allowable to short-circuit them, as they then impair the starting powers to such an extent that synchronism is too difficult to attain.

A novel feature of a motor constructed without this defect is that devised by Mr. Harry L. Tyler, of Corning, N. Y. This consists in employing for starting and for subsequent field excitation a motor which acts first as a starter and secondly as a revolving transformer. The accompanying Fig. 1 represents, diagrammatically, the relation of the circuits during the start-

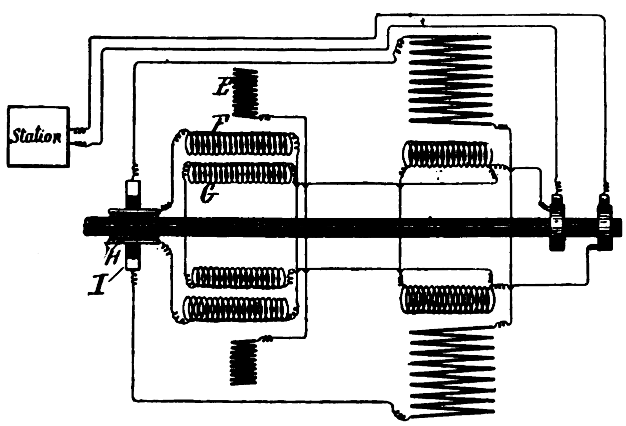


FIG. 2.—THE TYLER ALTERNATING MOTOR.

ing operation, and Fig. 2 represents a like view after synchronism is attained.

The revolving transformer and starting device are shown at B; C is the synchronous motor, and D the main line between motor and source. The revolving transformer and starting device is provided with the field coils E, armature coils F, and coils G. The coils F and G are supported and held in inductive proximity upon a core mounted on the armature shaft of the synchronous motor. On one end of the armature shaft is a commutator, H, provided with brushes. The synchronous motor C is arranged alongside of the revolving transformer on the same shaft, and is provided with the field coils J and armature coils K, the latter being in circuit with collector-rings L and M on the shaft.

The connections being established as shown in Fig. 1, the starting is effected in the usual way, the field coils E and armature coils F co-operating as in any motor until synchronism is reached. The coils G remain, of course, idle, until synchronism is reached, but when the revolving parts attain synchronism and the connections are changed, as shown in Fig. 2, the starting-motor becomes a revolving transformer, the coils G being the primaries and receiving alternating current from the line, while the coils F are secondaries and have induced in themselves alternating current of the same frequency as the line. The alternating current in coils F, as generated, is unavailable for the desired continuous excitation of the field of the synchronous motor, but as they are connected to the commutator H, and as the whole is revolving synchronously, it necessarily follows that the transformed current of coils F is delivered by brushes I as continuous, which is what is desired for the motor field excitation.

Mr. Tyler has also been devoting attention for some time to the development of an underground railway system. The system of distribution consisting of a single-phase underground circuit connected in multiple to primaries of transformers whose secondaries are in multiple with the track rails at intervals of 500 feet. Circuit-breaking apparatus is boldly discarded, the transformer primaries all being continuously connected to the underground mains while the secondaries remain constantly attached to the track.

Of course the entire track is thus constantly charged and it would seem that with the available potential the ground leakage as well as liability to personal shock would be prohibitive, but if we may believe reports, a mile of flooded uninsulated track with a voltage of 70 at a frequency of 300 per second shows a leakage of only 1,100 watts, while it is claimed to have been amply demonstrated that no perceptible shock is obtainable even with a hand held in contact with each rail. With a 1,000-volt Westinghouse alternator feeding the primary line at a frequency of 300 per second, a 7½ ton caboose has been propelled at a speed of fifteen miles per hour over the tracks of the Fall Brook Railway Company in the Corning yard, the single-phase motor on the caboose receiving power through the wheels at 70 volts.

A NEW SYSTEM OF SINGLE PHASE ALTERNATING CURRENT TRANSMISSION AND PERFECT ROTARY FIELD SINGLE PHASE POWER MOTOR.

BY J. G. J. SCOTT.

IT has been the endeavor of alternating current engineers for years to utilize single-phase currents for transmission of power to long distances and to apply such currents to long distance railway service. The transmission to distances has been accomplished with synchronous motors of different phases, some with fields excited separately by direct currents, and others being induction motors, or having the field and armature coils in series. All of these transmissions, however, have had faults that rendered them useless or inefficient except at full load, due to almost no regulation, in some cases between no load and full load, and in others the very large lagging current, and in all, the inability to start the loads they worked against. While the last fault was or is not fatal where motors are installed for power work where it is possible to use clutches, loose pulleys, and to start the machine with no load and then gradually put the load on after synchronism has been reached, the regulation factor has to be considered, and is in all single-phase systems very small when compared with direct current systems operating the same number of horse-power.

There are many places where it is necessary to vary the speed of a motor from its synchronous speed, and operate it for days at a time at these slower speeds. Again, it becomes necessary where a certain motor runs day after day at 6 or 8 horse-power, for it to develop 2 or 3 horse-power efficiently. With present types of single-phase motors it is impossible to change their speeds and have them do any efficient work if they are separately excited or induction motors.

Owing to the delay in getting into their new factory, the Scott & Janney Electric and Manufacturing Company, of Philadelphia, will be unable to get an exhibit of their new single-phase motors finished in time to show in operation in New York at the Exposition. They had hoped to be in a position to show their new single-phase rotary field street car motor, and the method of control. But it will be interesting for railway engineers to know that it is at last possible to operate single-phase motors for the propulsion of railway cars.

This new company have started into the field with a practical device, and have invented means of utilizing alternating

currents having a two-wire system. This is done by means of a device which they have termed an "induction director," by means of which, with ordinary single-phase currents, a great advantage is obtained over both direct current and polyphase systems, on account of the following facts: 1. The motors are non-synchronous. 2. They are differential in point of speed and torque to a very large degree. 3. They will be uncommonly light in weight for their output. 4. A perfect rotary field and magnetic poles of constant strength are obtained. 5. There are no dead points throughout a complete revolution of 360 deg. 6. The armature speed and the speed of poles traveling in field magnets are always identical; no matter what the mechanical speed of armature or the vibration of magnetism, the poles in both armatures and field magnets are synchronous. This is a most important feature. 7. The frequency is constant throughout the system, and is important. 8. The regulation is perfect, and on large loads at slow speeds there is great economy on account of the differential virtue possessed by these machines. 9. It is not as difficult to start a dead load with these motors as with direct current motors or with polyphase systems, and not near as much energy required from line. 10. The mechanical speed is independent of frequency. 11. There are no commutators and absolutely no sparking.

TELEPHONY AND TELEGRAPHY.

PROF. DOLBEAR'S AIR SPACE CABLE IN ENGLAND.

In 1882 Prof. A. G. Dolbear was in London, and there invented what he called an "air-space" cable for telephonic work. The conductor was to be inclosed in a paper tube, larger than the wire itself, so as to have air as an insulator and dielectric where rubber had been used before. He described three ways of making such a cable: one having the conductor lying on the bottom of the tube; the second having the conductor kept concentric with the tube by winding it with twine, and the third by winding the conductor with loose fibrous material. The paper tube inclosing the conductor was to be afterwards covered with waterproofing material and a shield when needful. Such a cable, he claimed, would have a much higher working rate on account of its low capacity. This patent was issued in England in March, 1882. Prof. Dolbear could find no one who would undertake to build such a cable although it was recognized to have superior qualities. He went to Mr. Latimer Clark, who was then making cables, also to the Silvertown Cable Company and to others, but none would touch it. It was not until laws were passed making it obligatory for telephone companies to bury their wires that such a cable became a necessity. Then such cables began to be made in great quantity both in England and America. For ten years nothing could be done with the patent, for there was no demand. Meanwhile the telephone interests of Dolbear had involved extensive and costly litigation, ending, as all know, in a decision adverse to him and leaving him hors de combat, unable to cope with infringers either at home or abroad. In 1892 Dolbear sold to the British Insulated Wire Company his English patent for £10, as there seemed no hope of getting more for it, and that company went extensively into the manufacture of the Dolbear cables, so that in three or four years there were laid some thousands of miles of it. Other companies also were manufacturing it without any acknowledgment.

The patent was to expire in March, 1896, and it was thought by the British Insulated Wire Company that as the inventor had not profited in proportion to the merit of the invention possibly the British government might grant an extension of the patent for a small term of years and an application for such extension was made. Some of the most eminent patent attorneys in England were employed, with Mr. Fletcher Moulton as chief. For electrical experts there were engaged Dr. John Hopkinson, Prof. S. P. Thompson, Mr. W. H. Preece, Mr. S. Z. Ferranti, Mr. G. H. Nisbett, with Prof. Dolbear. The hearing was before the Judicial Committee of the Privy Council, a body of Lords.

There was a little effort made by the opposition to show that the cables made by other companies were not the Dolbear cable, but Ferranti, Hopkinson and Nisbett testified that they were all the same thing and that there were no anticipations of the Dolbear cable. The applicant was not able to show that he had done anything with his cable patent during the ten years from 1882 to 1892 and the decision of their lordships was that this lack of activity was fatal to the application and it could not be granted. The witnesses, Mr. Preece and Prof. Thompson, who were present in order to testify why nothing could have been done were not allowed a hearing. The British Insulated Wire Company spent about $20,000 in this attempt, which shows how valuable they held the patent to be.

The American patent for the same invention was not taken out for three or four years after the English one, and by limitation of course, expired with the English patent. If the English patent had been extended as had been hoped, it might have had an important bearing on cable business in this country, for the British company proposed to establish a cable industry here, and with the American patent collect the royalties due for the millions of feet of the Dolbear cable in use in this country.

THE STROWGER TELEPHONE SYSTEM FOR NEW YORK STATE.

A CONTRACT has been closed, says the New York Journal, between the Automatic Telephone Company, of No. 35 Wall street, and a syndicate composed of some of the prominent capitalists of this city, Buffalo and Rochester, which will give to the persons interested the right to construct telephone lines and establish a long distance telephone service between all sections of New York State outside of that portion comprised in Greater New York. The system which will be used will be the one controlled by, and known as, the Automatic Telephone Company.

The syndicate has no corporate existence, and its representatives in making the contract act by private agreement with the men who are to furnish the money. It is believed that the money involved in this deal will be considerably more than $3,000,000. A charter will be applied for within a very short time, after all the necessary details have been decided upon.

Several thousand automatic telephones have been contracted for, and the agreement requires that not less than 1,500 shall be installed each year, during the life of the patents.

J. Wesley Allison, president of the Automatic Telephone Company, and W. Seward Webb, one of the persons interested in the syndicate, left New York last night for Buffalo, where many of the details connected with the sale of the rights in New York State will be further decided upon in connection with the Buffalo capitalists who are interested in the transaction. Among those who are in the syndicate are Tracy C. Becker, president of the State Bar Association, of Buffalo; William B. Rankine, vice-president of the Cataract Electric Company; Edward Mickel, a capitalist of Buffalo; John Jacob Astor, C. F. Cox, vice-president of the Canada Southern Railroad; William C. Whitney, Smith M. Weed, Silas B. Dutcher, of the Hamilton Trust Company, of Brooklyn; William L. Trenholm, president of the American Surety Company; John C. Maguire, Surveyor of the Port of New York; George S. Hart, president of the Second Avenue Railroad, and the banking firm of I. & S. Wormser.

It is expected that the first exchange to be constructed by this syndicate will be at Rochester, N. Y. Work will probably be begun there within the next two or three weeks. Buffalo will next be supplied with the automatic telephone, and then in turn the principal cities in the interior of the State through to Albany.

While this work is being done the consummation of a scheme for the construction of the same system in this city will be pushed. Already the agents for the telephone company have begun operations here, and the statement was made yesterday that over nine thousand contracts have been signed by subscribers. No franchise has been obtained by the company as yet, but those who are interested in the company feel confident that some means will be obtained within a very short time for either obtaining a new one or purchasing a franchise which is already in existence.

The Automatic Telephone Company was incorporated a year ago, with a capital of $6,000,000. It controls 160 patents and has thirty exchanges, the most important being Colorado Springs, Col.; Michigan City, Ind.; La Porte, Ind., and Trinidad, Col. The officers of the company are J. Wesley Allison, president; H. N. Whitney, of Kissam, Whitney & Co., treasurer, and A. B. Macklin, Secretary. The main feature of the system is that the switchboard operates automatically, and the familiar "Hello; What Number?" from the telephone girl, who frequently has not time even to say that much, will be done away with. As far as experiments go, the system has given satisfaction, and it is claimed that it can be operated on a much more economical basis than the Bell. The syndicate is negotiating for the control of the New England States, and it is not unlikely that within a few weeks additional contracts will be given them for this territory, which they will merge in one extensive system.

Exhibition Notes.

OPENING OF THE ELECTRICAL EXPOSITION.

BETWEEN 6,000 and 7,000 persons assembled in the main hall and galleries of the Industrial Palace on Monday night to witness the ceremonies attending the opening of the Electrical Exposition.

Shortly after 8 o'clock Governor Morton entered the space reserved for him in the gallery, accompanied by his private secretary, Colonel A. W. Cole, and by the reception committee, including Messrs. C. H. Wilmerding, president of the N. E. L. A., Mayor Wurster, of Brooklyn, Mr. F. W. Hawley, Mr. H. H. Vreeland and Mr. T. Commerford Martin.

After a brief introduction by Mr. Wilmerding, Mayor Wurster, in the absence of Mayor Strong, assumed the chairmanship of the meeting and in a few well chosen remarks introduced Commodore Perry Vedder, who delivered an address on "The Electric Era." The speaker dwelt at length on the great progress made in the electric arts in a comparatively brief period of time and concluded by stating his belief that "the greatest living traveler in electricity was as a child on the seashore of knowledge."

At the conclusion of Commodore Vedder's address, Governor Morton arose, and after expressing his thanks for the honor conferred upon him, declared the Exposition open. At the same instant he pressed a golden key—the same that had been used by President Cleveland in opening the World's Fair at Chicago—and thereby closed postal-telegraph circuits which fired cannon simultaneously in San Francisco, New Orleans, St. Paul, and Augusta, Me.

During the address of the Governor the Moore vacuum tubes, arranged as a frame around the speaker, were lighted as well as an emblem, "Let there be Light," and below it the initials "N. E. L. A."

Letters of congratulations were received from the mayors of Augusta and New Orleans, and from Mr. W. H. Preece, Engineer-in-Chief of the British postal-telegraphs.

After the ceremonies the thousands of visitors scattered throughout the building to inspect the exhibits, nearly all of which were in order. The crush was so great that at times locomotion was almost impossible. If the opening night is any indication for the future, the success of the Exposition is assured.

THE EXHIBIT OF THE NEW YORK EDISON COMPANY.

The exhibit of the Edison Electric Illuminating Company, of New York, is situated directly under the overhanging extension of the first gallery along the south side of the main hall, the space occupied being 84 ft. long by 10 ft. wide. As the visitor enters the main hall from the stairway, he will see a pictured representation of the great operating room of the Duane street central station, in front of which will be shown actual sections of the electrical controlling apparatus constructed on the Van Vleck edgewise system, similar to that in use at the Duane and Twelfth street stations. The apparatus in the center consists of a dynamo controlling section complete with edgewise ampere meters for regulating two large-size multipolar dynamos; while at the side, near the column, is shown the feeder controlling apparatus, having a capacity sufficient to control both poles of four feeders each of 1,000 amperes capacity. Current for this exhibit is supplied to this feeder switchboard from the Edison street mains, and from a storage battery, to be seen behind the exhibit, similar to the batteries in use in the Edison stations. From this switchboard, the current passes through an Edison feeder-tube, such as is used in the city street, after which it passes into a feederbox, thence to a distributing box, and thence through a street main to a service-end box, such as is placed on a consumer's premises. Alongside the feeder box is one of the new controllable junction boxes, as developed by the company, by which a tie-feeder between two stations can be divided from the station into individual service feeders. From the service-end box, current is carried through an Edison chemical meter, such as is usually placed in a customer's premises, and also through a Thomson wattmeter; after which it is distributed for its varied applications in lighting (incandescent and arc), power, cooking, heating, etc. Two arc light posts, constructed on the Edison-Bowker system of street lighting, and similar to those in use on Fifth avenue, are placed at the front of the exhibit.

In the center of the main exhibit is seen an illuminated representation of the upper field frame of the huge 800 kilowatt dynamos now in use at the Duane street station, the largest lighting generators in the world, capable of supplying current for more than 12,000 16 c. p. lamps.

In the next space beyond is shown an interesting collection of various electro surgical and dental apparatus, together with electric fans and an electrically driven sewing machine. Electric cooking is also shown in practical operation, with electric ironing, and electric heating; an "electrotherm" for bedwarming, poulticing, etc., will be of interest, as well as many other applications. The power exhibit at the extreme end includes a modern printing press run by electricity without belt or shafting. Elevators run by electric current are shown elsewhere in the building.

Directly behind the large dynamo field frame is an interesting collection of photographs of the principal stations, supplying more than 6,000 customers, with over 300,000 incandescent and 3,700 arc lamps, and about 15,000 horse-power for power and miscellaneous purposes, forming the largest installation of any electric supply company in the world. In addition to this exhibit in the main hall, there is an electrical dark room, in which is a joint exhibit of electric lamps manufactured by the General Electric Company, and supplied by the Edison Company. This room illustrates various methods of lighting, including the latest plans for using reflected light from concealed lamps. Electric signs and advertising specialties are also here exhibited.

THE MEDBERY INSULATION AT THE EXPOSITION.

The Fiberite Company, of Mechanicsville, N. Y., display a full and complete line of their insulating materials for overhead trolley equipment and Medbery insulation, which is so generally used on the leading electric railways of the country.

They also display a very handsome line of switches of every kind as well as a very substantial switchboard for lighting and power purposes.

This display is in charge of Wendell & MacDuffie and Mr. H. J. Medbery.

THE WARREN ALTERNATOR AT THE EXPOSITION.

The Warren Electric Company, of Chicago and New York, display on the first floor, one 60 kilowatt Warren alternator, alternations 9,000 per minute, connected for 110 volts, of their latest induction type, stationary armature and stationary field coil machine; also one 45 kilowatt Warren alternator of the same general style.

This machine is having a very large sale, having only recently been put on the market. These machines have been in use about a year and not a single dollar has been spent upon one of them for repairs.

These machines are in charge of Wendell & MacDuffie and Mr. H. P. Hill.

APPARATUS FOR THE PRACTICAL LABORATORY.

In addition to the historical apparatus to be loaned the Exposition by Dr. R. Ogden Doremus, the following pieces of the laboratory type have also been placed at the disposal of the management: From Bellevue Hospital, Medical College, egg shaped globe for exhibition of the electric arc in vacuo; same for exhibition of electric arc in water; Hoffman apparatus for decomposition of water. From the College of the City of New York, models showing beautifully the operation of the telephone; Erdmann galvanometer; ampere table; apparatus for development of heat by current and quantitative estimation of same; revolving Geissler tubes; Hertz mirrors; photophone; exhibition of diamagnetism. This will all be in more or less continuous operation.

LOAN OF HISTORICAL TELEPHONE APPARATUS.

Mr. E. J. Hall, Jr., vice-president and general manager of the American (Long Distance) Telephone and Telegraph Company, has very kindly loaned to the Exposition the original long distance telephone set with which some years ago Prof. Alexander Graham Bell opened the line between New York and Chicago. It has since that time been jealously guarded, and has had a silver plate put upon it with the inscription as to date, etc. Mr. Hall accompanies this with a large picture, illustrative of the event, and with other material bearing upon the occasion.

Mr. C. R. Truex has been entrusted with the care and arrangement of this interesting exhibit, which goes in the collection of the Historical and Loan Exhibit Committee.

MISCELLANEOUS.

THE RELATION BETWEEN THE ELECTRICAL TRADE AND THE HARDWARE BUISNESS.[1]

BY JULIUS M. AFF.

THE question naturally arises, is it advantageous to a retail hardware dealer to sell electrical supplies? Above everything else, does it pay to keep them, to advertise, and to install them if necessary? In fact, is the hardware store a proper place for the sale of electrical goods?

In my opinion a hundred dollars judiciously invested in first-class electrical goods will pay as well as anything that you may have in your store, providing your salesmen know their business, know how to satisfactorily explain to your customers the working of all appliances, and can make suggestions as to possible ways and means to accomplish a desired result, and as to remedies for existing faults. Such a stock of goods need not extend beyond what is known as household electric supplies, covering such appliances as are now to be found in most all well appointed modern houses.

Customers' Inclinations.—What is more natural for any one who may want to purchase an electric bell than to go to the nearest hardware store for it? Are electric bells any less in our line of goods than the old-fashioned jingle bells, or push buttons less so than bell pulls? Does the fact that copper wire is covered with some insulating material exclude it from the hardware store? If there is any place on earth suitable for the sale of electrical supplies it is a hardware store.

Installing Electrical Appliances.—As to doing electrical work, putting in electric bells, etc., it would be advisable for the hardware merchant to keep a competent electrician at his store at all times, one who can turn a hand to most any kind of work when not very busy in his own line; and when Dr. Smith's or Dentist Jones' front door bell is out of order they could be accommodated at once, which fact they would very much appreciate. Insist upon having your workman do all work to the best of his ability, and if by reducing the profit on the job by a few cents you can give your customer better work, it will pay you very much better to do it than to send again in a short time, and spend hours in locating faults in material or workmanship. Many installations are unsatisfactory through insufficiency of battery power since the efficiency of batteries decreases as they become older. One or two cells over and above what is absolutely necessary represent a small item of expense, tend to make everything work more positively, and the whole battery will not require recharging so often, as it does in cases where the battery is just sufficient to do the work while the whole installation is new.

Again, I say let your material be of the very best that can be procured, since the best is none too good for a first-class job, and no other kind of work should be done by any one who expects to make his work pay.

Unsatisfactory Work.—Any one desirous of having a good and lasting job of electric work done would prefer going to a reliable hardware merchant who has a reputation to uphold, one who would rather lose money on the job than give his customers just cause for complaint, than to employ some person unknown to him or to any one else who may be here to-day and somewhere else to-morrow, either measuring ribbon or selling stove polish, but who knows all about electrical work when he sees a chance to make a few dollars. To an individual of this type the question of cost, of time and of material is only a secondary consideration. He does the job at cut-rate prices, with the result that the trusting victim comes to your store about one month after that asking the price of putting in an old-fashioned jingle bell, and at the same time condemning electric bells and everything connected with them. Then is your chance to rectify the trouble and gain the custom of this man and of many others through his influence.

Adaptability of Electrical Appliances.—The range of usefulness and the conveniences which a few cells of battery in your house or place of business can afford you is almost beyond enumeration. The slightest pressure of a finger will ring any number of electric bells, irrespective of size or distance, from one single push button. One single bell may be rung from any number of pushes or other contact devices. Simply pulling a chain will light or put out the gas. Automatic gas lighting burners can be lighted or put out at any distance by simply pushing a button, opening or closing a door or window, entering or leaving a room, and in various other ways. An ordinary electric alarm clock in connection with other electric appliances can, while you are absent or asleep, light your gas or electric light; light your gas stove, and have the water boiling by the time you are ready to use it; feed your horse or cattle; awake you or your servants, and afterward keep on ringing until you get up and turn off the current. The electric burglar alarm informs us that some unwelcome visitor is trying to force an entrance, and at the same time designates the place where he is at work.

In burglar alarm work we recognize three distinct systems: The first is the open circuit system, which is the one mostly used for interior house work, where all wires can be concealed, since the cutting of one single wire may disable the whole installation. The second is the closed circuit system, which is more adapted to outside work, such as protecting a barn or warehouse, or anything where connecting wires to the owner's house are visible and accessible to most any one. In this case the cutting of wires would result in ringing the alarm, whereas simply short circuiting would disable the system. The third is a combination of both the open and closed circuit systems, and neither cutting of the wires nor short circuiting them will affect its working.

Additional Applications.—The electric thermostat or heat controller regulates the temperature automatically in our homes, greenhouses, incubators, etc., or at the very least notifies us when it is getting too warm or too cold for any particular purpose. The electric automatic fire alarm is just such a thermostat. The telephone would be almost useless without its battery. Electric door openers will open our doors at a distance and save us many a tiresome walk up or down stairs. Electric matting, laid under carpet, will inform us of the presence of some one at that place. High and low water alarms and regulators in boilers or tanks can automatically control the flow of water. In the sick room electricity adds materially to the comforts and even health of the patient by running fans to cool the fever-parched body, indicating the proper time for taking medicines, and in the hands of the skillful surgeon electricity is of untold value in the saving of human lives. Mining and blasting accidents are less frequent since we employ electricity to ignite the most powerful explosives.

Permanency.—The mechanically inclined boy who formerly aimed to be the happy posssor of a tool chest, fret saw, lathe or steam engine, now includes in his outfit electric batteries, bells, toy motors and magnets of all shapes, and delights in making movable toys of all descriptions, since he has found in electricity the only convenient motive power for them.

You as a possible buyer might say: "Will a system do all this work after it is put in and paid for; and, if so, how long will it last?" I will here say that there is no reason why the installation should not last as long as the very building where it is put in, if the job is properly done and correspondingly paid for. When architects become more explicit in their specifications, and invite only responsible bidders, then we shall have better work and a general stimulation of the electrical trade.

[1] A paper read before the Philadelphia Hardware Association. Mr. Aff is with the hardware firm of J. Jacob Shannon & Co., of Philadelphia.

MOTOR REGULATION BY FIELD VARIATION.

BY PROF. W. A. ANTHONY.

IN The Electrical Engineer of April 15 I find a description of Burke's "Method of Regulating Motors." The writer of the article omits to mention one method of varying the speed, namely, varying the field of the motor, and, furthermore, it seems to me his way of stating the case is likely to lead to a misapprehension as to the size of the machines that will be required.

As he states the problem, it is "to deliver 10 horse-power at any speed between 100 and 500 revolutions * * *" But the cases are extremely rare where such a condition will exist. Usually the condition to be satisfied is more nearly that of constant torque than of constant power. In running a printing press, or an elevator, in every case where the work to be done can be likened to friction overcome or a weight lifted more or less rapidly, the power increases at least as rapidly as the speed.

Assume that the motor is used to run an elevator and that at a speed of 100 the power required is 10 horse-power. At 200 revolutions the power required would be 20 horse-power, and at 500 revolutions 50 horse-power. But at a speed of 200 revolutions one motor must do all the work, and it must therefore be a 20 horse-power motor at that speed. The speed of 500 revolutions is obtained by making one of the motors act as a generator, and, assuming the voltage of the line to be 100, the generator must add 150 volts. Now the one machine must furnish 50 horse-power to run the elevator and 75 horse-power to run the generator coupled to it, or 125 horse-power in all, and this assuming the efficiency of the combination to be 100 per cent.

But to assume the conditions of the article, that 10 horse-power is to be delivered at all speeds. At 500 revolutions the motor must deliver 10 horse-power to the work and 15 horse-power to drive the generator, which must add to the voltage of the circuit the 150 volts necessary to obtain the speed of 500 revolutions. The motor must, therefore, deliver 25 horse-power when running at 500 revolutions, but if it can deliver 25 horse-power with full strength of field it can deliver the 10 horse-power of useful work with the field reduced to two-fifths its normal strength, and with that strength of field it would run at 500 revolutions on a 100 volt circuit. By making one machine capable of delivering 10 horse-power at 100 revolutions—a machine that would be less costly than two machines of 5 horse-power each—the regulation of speed could be obtained by varying the strength of its own field, with the same facility as by the method described by Mr. Burke.

In short, the method described by Mr. Burke will require, to deliver 10 horse-power at all speeds, from 100 to 500 revolutions, two machines of such size that they would, if properly wound, give 25 horse-power each, or 50 horse-power total at 500 revolutions, and at the normal voltage of the line.

If the power is to increase with the speed, as in running a printing press, or a street car, or an elevator, with 10 horse-power as the minimum, then the two motors would need to be of such size that if properly wound they would deliver at least 125 horse-power each at 500 revolutions, or a total of 250 horse-power.

In the system which supplies a varying voltage to the armature of the motor by means of a rotary transformer this last result may be accomplished by means of three machines of 50 horse-power each, or 150 horse-power in all.

THE BREVOORT METHOD OF WATERPROOFING FABRICS.

A PATENT has just been issued to the executors of the late Henry L. Brevoort in which that inventor describes a novel process for waterproofing textile fabrics.

In carrying out the process, the fabric to be treated is wetted with water and placed between sheets or rollers. One of these sheets or rollers, which is preferably of tin or aluminum, is connected to the positive pole of an electric generator and the other sheet or roller to the negative pole. By employing such a dissolving positive electrode and passing current through the wet fabric the fibers are made water repellent.

The inventor states that the waterproofing is due to the formation on the positive conductor of a metallic oxide of some kind produced by the liberation of nascent oxygen on the positive conductor due to the electrolytic action of the current on the water with which the goods are saturated, and which oxide enters into the fibers of the goods aided by the current, and probably is combined partly chemically and partly mechanically with the fibers, making the same waterproof by the presence of the oxide in or on the fiber.

The strength of the current applied depends upon the character of the goods submitted to treatment, but care must be taken not to carry the process too far. The nascent hydrogen on the negative side will, if the time of treatment is too long, accumulate and then begin to act as a reducing agent, and in case the period of treatment is prolonged beyond the proper time then the nascent hydrogen will reduce the oxide of the metal in the goods to the metallic state and the combination or union of the oxide with the fibers will be destroyed by the reduction of the oxide to a metallic state.

This process is said to have the great merit of making the individual fibers and threads water-repellent, while the pores of the goods are in no way stopped up or closed. Consequently, if used on clothing, it would not prevent evaporation taking place through the interstices between the threads.

CINCINNATI ELECTRICAL NOTES.

MR. JOHN CABOT, city electrician of Cincinnati, has instituted a novel experiment in the electrical equipment of a house.

The "sensitive room" properly speaking, is a room fitted up with electrical apparatus, and so contrived as to transmit any conversation occurring between persons confined therein. Mr. Cabot fitted up such a room in the Central Police Station, with invisible electrical appliances, so as to make every word uttered in the cell audible to the listeners stationed in the connected room on the top floor

The cell is slightly larger than that of the average police station cell, with a partition running through the center, in which the prisoners expected to converse with each other are placed. There is nothing unusual about the rooms, all the appliances being concealed from view, excepting one or two small copper tubes, which would attract no attention.

On the front of the cell, midway between the two iron doors, is attached a simple wire screen, ordinarily used to cover and protect fumigating boxes, being modeled after the system now in vogue throughout the cell rooms in the Cincinnati Police Station. Just beneath this is a novel arrangement, through which the sounds are transmitted to the "watch room" above. To this contrivance, wires and tubes are attached, which are arranged in a deceptive manner, so as to make it appear that the wires and tubes join those leading to the hydrant. This is done in order that the suspicion of the inmates may not be aroused.

Any conversation occurring in this room passes through the wire screen and into the transmitter, and thence into the ear of the authorized eavesdropper in the receiving room above.

This device was suggested by the necessity for some such contrivance on account of the inability to procure incriminating evidence against George H. Jackson and Alonzo Walling, the medical students, who are supposed to have murdered Pearl Bryan, who was found dead near Cincinnati in February.

It was impossible to obtain incriminating evidence against either prisoner, but when placed in these cells, they seized the opportunity to converse with each other, having been separated previously; the device above referred to then came into play, and by that means a lengthy conversation was transmitted and overheard, which will doubtless convict them both.

The Cincinnati Street Railway Company has applied to the Legislature, through what is known as the Rogers bill, for a fifty years' extension of its franchise, which would expire under the present franchise in sixteen years. The company, of which Mr. John Kilgour is president, and James A. Collins secretary and treasurer, is meeting strenuous opposition from the press and people, who seem inclined to give the measure the "marble heart," claiming that the street railway already pays a high interest on an inflated capital, and should be allowed no further advantages.

If the bill passes the company will remove the somewhat antiquated cable car, and run all lines by electricity.

THE PHILOSOPHER'S STONE AT LAST.

A special dispatch from Cedar Rapids, Ia., of April 20 says: George Johnson, a young farmer residing in Jefferson County, a graduate of Columbia College, who has been experimenting with the X-rays, thinks he has made a discovery that will startle the world. By means of what he called the X-rays he is enabled to change in three hours' time a cheap piece of metal worth about 13 cents to $153 worth of gold. The metal so transformed has been tested and is pronounced pure gold.

A BOOK ON ROENTGEN RAYS.

A book that ought to be very successful is announced on "Röntgen Rays," and all the experiments concerning them. The author is Mr. E. P. Thompson, and his collaborators are Prof. W. A. Anthony, L. M. Pinolet and Ludwig Gutmann. The work will be very comprehensive. It is to be brought out by the firm of D. Van Nostrand Company. It cannot appear too soon.

SOCIETY AND CLUB NOTES.

TRIP TO THE CROCKER-WHEELER FACTORY.

On Thursday evening, by special invitation, the National Electric Light Association and its friends will make a trip by special train to the factory of the Crocker-Wheeler Electric Company, at Ampere, N. J. Special tickets have been issued for this very interesting trip. The special train leaves Christopher and Barclay street ferries at 8.10, and provision has also been made on other trains. The big new factory is an ideal exemplification of what is being done in the construction of motors and dynamos and the interior transmission of power. Dr. S. S. Wheeler, president; Prof. Crocker, Mr. Lufkin, Mr. Dunn and others will receive the guests.

THE HENRY ELECTRICAL CLUB.

Prof. F. B. Crocker will deliver a lecture before the Henry Electrical Club on "Troubles in Dynamos and Motors," on May 8.

THE A. I. E. E. AT THE KELVIN CELEBRATION.

The American Institute of Electrical Engineers has been invited to send a representative to take part in celebrating the jubilee of the professorship of the Right Honorable Lord Kelvin, which will take place in Glasgow, June 15 and 16.

President Duncan has appointed Past-President Martin to represent the Institute on this interesting occasion. Mr. Martin will sail on June 6, and while absent will lecture before the Royal Institution on the subject of the Niagara Power Plant.

ELECTRIC TRANSPORTATION.

THE K. A. K. SURFACE AND SUB-SURFACE ELECTRIC RAILWAY SYSTEM.

WHILE the trolley electric railway has had a deserved success, indications point strongly to large application in the future of the conduit system. Enough has been demonstrated to prove the practicability of placing railway wires below the surface of the ground, and it is probably only a question of time when, in our larger cities at least, the trolley will give place to the conduit. At the same time inventors are looking forward to the time when steam roads will be forced to employ electricity, and a step in that direction has been made by Messrs. Knotz, Allen & Kelly, of Springfield, Ohio, in their so-called K. A. K. electric system. The conduit employed in this system for steam roads is shown in cross-section in Fig. 1. It is composed principally of steel casings, with substantial cast iron yokes or frames, about six feet apart, making a very substantial conduit, the yokes forming the supports for the pipes and lids also shown.

Referring to Figs. 1 and 2, A A is the supporting yoke, D^3 ordinary gas pipe 1½ to 3 inches diameter, supported by insulators D^1. In this gas pipe are placed the feeders E, which extend the entire length of the track, and connected to these at suitable distances of 500 to 700 feet, by means of switches and fuses inclosed in water-tight boxes, are auxiliary feeders E^1, each of sufficient size to carry the current and for feeding independent sections of the rails, C, of the same length, or the distance between the switch boxes. This admits the cutting out of any section of rails, C, either automatically for cause or when necessary for inspection, without interfering with the operation of the line. Contact between supplementary feeders E^1 and rails, C, is made every twenty-four feet by the bolts D^5 which passes through the insulators D^4, which enters the pipe through the T-couplings D^2.

The insulators for supporting the pipe and the rails on the pipe are large, and especially designed for this purpose. The contact rail C is of steel, presenting a wide surface for contact with the trolley shoe. It will be seen that for any of the current to escape it must pass through a quadruple insulation; that is, the insulation inclosing the feeders, and the insulators supporting the gas pipe, which inclose the feeders on the positive side, also through a like insulation on the negative side.

Inasmuch as the insulated feeders are inclosed in the airtight tubes or gas pipes, and free from all atmospheric conditions, and the tubes also exceedingly well insulated, it reduces the possibility of the current breaking through this insulation, to a minimum.

In the form of conduit designed for street railway purposes the insulators are supported on a frame upon which the lead-covered feeders are supported. There is no supplementary wire, but a direct connection from the switch to the contact rails, which are banded together in lengths corresponding with the distances between the switches.

A line equipped on the K. A. K. system is now in operation in the streets of Springfield, Ohio.

STANDARD UNDERGROUND.—Mr. P. H. W. Smith has been appointed assistant general manager of the company, and Mr. F. S. Viele has been made manager of the conduit and general construction departments at Pittsburg.

CAN ELECTRICITY SUPPLANT THE STEAM LOCOMOTIVE ON TRUNK RAILWAYS?—XI.

BY

Wm. Baxter, Jr.

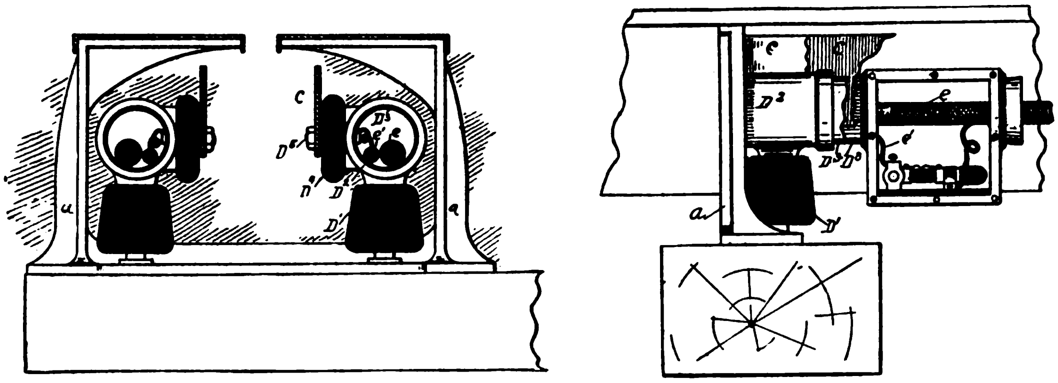
WE have seen from what has preceded that we can cut off seventy per cent. of the cost of repairs to locomotives because these repairs are made on parts of the machine that have no counterpart in the electric system. There then remains thirty per cent., which covers the cost of repairs to the machinery proper of the locomotive, that is, the cylinders, pistons, crossheads, connecting rods, valve rods, link motions, etc. Now, it is evident at a glance that the cost of keeping up these parts must be very much greater than the cost of repairs to motors. The wearing parts in a motor mounted on the axle would be the two journals and the commutator.

When the great difference in the number of wearing parts is taken into consideration it must be conceded at once that at the most the cost of repairing the motors could not be more than one-half of what would be required to keep up the machinery proper of a steam locomotive. This being the case, the repairs of motors would amount to only fifteen per cent. of the repairs of locomotives.

It may be said by those who are familiar with the history of electric street railways that this assumption as to the small cost of maintenance of motors is not justified, in view of the fact that the actual operations of such roads do not show such results; but it must be remembered that the difference between the cost of repairs on modern equipments and those made several years ago is very great. The principal causes of deterioration in early machines were that they were made of too small capacity to do the work required of them, and also that the insulation was not as perfect as it might be. The gears were not encased and consequently soon wore out under the action of grit and mud. The journals were not dustproof, and therefore the brasses had to be frequently renewed. Lightning did a great deal of damage, owing to the imperfect protection of arresters and the defective insulation of motors. Motors made to replace locomotives would be free from the defects of the earlier machines used on trolley roads; in fact, they would be far more substantial than the motors of small size now being turned out by the best makers. The designers of such machines would not be hampered by any restrictions as to size or weight, therefore every part could be made of ample size to allow for the most substantial insulation, liberal cross section of wire, and large wearing surfaces. Machines so constructed would be almost everlasting.

The assumption that the cost of repairs to motors would be fifteen per cent. of the amount expended on locomotives is really unfair to the electric motor. This relation would hold good for an equal number of locomotives and motors, but as a motor car could easily make fifty per cent. more mileage, the number of motors required to do the work would only be two-thirds, so that, as a matter of fact, the cost of maintaining the electric equipment of a road would be nearer ten than fifteen per cent. of the cost with locomotives.

The next item to be considered is that of repairs to shop machinery and tools. We will pass over this lightly because the amount is small and it would make but little difference in our



FIGS. 1 AND 2.—THE K. A. K. ELECTRIC RAILWAY CONDUIT SYSTEM.

calculations whether we include it or not. But it is evident that a reduction can be made, because as the repairs to roadway, bridges and motive power are greatly reduced, fewer men would be required in the shops for this part of the repair work, therefore the cost of keeping up the machinery and tools would be less. As this expenditure in maintenance of machinery and tools no doubt covers those used for car repairs as well as for the purposes here enumerated, it is probable that not over one-half of the amount would be affected by the reduction. We might justly assume that this half could be reduced twenty-five per cent., which would equal about twelve per cent. of the whole bill, but in order to be well within safe limits, we will call the saving only five per cent.

We now come to a charge that is of very decided importance, that of wages of engineers, firemen and round-house men. We see from Table 13 that this item amounts to $3,222,974.47. From Table 14 we find that the total of engineers and firemen amounts to $3,169,465.05, from which we can conclude that the wages of round-housemen amount to $53,509.42. As has already been shown, the wages of firemen can be saved by using motor cars, because in passenger service the baggage car could be used for this purpose, and on freight trains the caboose; and in either case the other men in the car could be required to remain in the motorman's compartment while on the road, so as to be ready to take the lever in case of emergency. The round-housemen could be reduced fully one-half, if under this head are included the men who clean up the engines, as with motors there would be practically no cleaning to be done. Making this assumption, we would find that we could reduce this item by $1,147,103.51, an amount which is about 36 per cent. of the entire charge for this service and constitutes nearly 2.8 per cent. of the total expenses of operating the road. We will next take up the cost of fuel for locomotives. To determine accurately the saving we would have to know the amount of coal consumed and the relative proportion allotted to passenger and freight service and also to switching engines. The report only gives the total cost, and therefore the weight must be estimated as well as the cost per ton. In previous paragraphs an estimate was made of the total power required to draw freight trains on the Pennsylvania road, and this was carried out far enough to show the number of tons used per year. If the calculation is correct this number would be 1,183,220 tons.

In making this calculation we were assisted by the fact that the report gives the average amount of freight per train and the average speed. Having this data, it is possible to calculate with a fair degree of accuracy the power required to draw the average train, and thus to obtain the average coal consumption. As the number of freight train miles is also given, the simple multiplication of the coal consumed per mile by the train miles gives the total consumption for the year. If we could obtain the same data for passenger trains on the Pennsylvania road as for freight, a similar calculation could be made, but unfortunately there are no data in the report from which any accurate estimate of the average number of cars in a passenger train can be made; therefore no calculation as to average power and coal consumption can be given, as it would have to be based wholly on assumptions; but it is generally conceded that a coal consumption of 65 pounds per train mile for passenger work is about as good a result as can be obtained on an average. Estimating the coal consumption of passenger trains on this basis, we would have:

$$\frac{14,908,880 \text{ (train miles)} \times 65 \text{ (lbs.)}}{2,000} = 484,538 \text{ tons (approx.)}$$

Assuming the coal consumed by switching engines to be at the rate of 100 pounds per mile, we would have:

$$\frac{10,298,317 \text{ (miles)} \times 100 \text{ (lbs.)}}{2,000} = 514,966 \text{ tons.}$$

This number of pounds of coal per mile for switching engines must certainly be under, rather than over, the actual amount, as will be evident when we consider that such engines cannot average as many miles per hour as freight trains, owing to the fact that they only make short runs, and then wait a considerable length of time before making another run, so that although they may be in service all day long with a full head of steam on, the actual number of miles run would not be very great.

From the foregoing estimates we would get the total number of tons of coal consumed per year as follows:

For passenger engines	484,538 tons
For switching engines	514,966 tons
For freight engines	1,183,220 tons
Total	2,182,724 tons

The cost of this amount of coal as per the report of the road is $3,724,481.14, therefore the cost per ton is nearly $1.71.

If these calculations are correct, then the average cost of coal per ton as given above is not far from the actual figures, and by taking the number of tons used in each branch of the service and multiplying by this price, we can get at least an approximate apportionment of the fuel bill to the different classes of work. Doing this we get the following results:

Passenger service	484,538 tons @ $1.71 =	$826,800 approx.
Freight service	1,183,220 tons @ $1.71 =	2,018,900 approx.
Switching service	514,966 tons @ $1.71 =	878,781 approx.

In calculations already made we have shown that the cost of coal per unit of work done by electricity would be about 31 per cent. for freight and 37 per cent. for passenger work of the cost of the same service by steam. Reducing the above amounts by these percentages, we would have the following figures as representing the cost of coal consumed for passenger and freight service by electric motor:

Passenger service	$826,800 × .37 =	$305,916
Freight service	$2,018,900 × .31 =	625,859
		$931,775

As already pointed out the coal consumption of switching engines per horse-power hour must be very high on account of the intermittent character of the work, but the efficiency of electric motors in this service would be just as high as in any other, as no current would be used while not in motion; while in a locomotive the coal is burning up all the time, whether in motion or not. Now, if a saving of 69 per cent. can be made in doing the freight work, it is undoubtedly reasonable to assume that the work of switching engines could be performed at a saving of from 80 to 85 per cent. Taking the lowest figure we would have:

Cost of coal for switching engines, 514,966 × .20 = $102,993.

The total cost of coal for all services would be:

For freight and passenger	$931,775
For switching engines	102,993
Total	$1,034,768

Total saving in fuel item, $2,689,713.14.

Percentage of fuel bill saved (about) 72 per cent.

Percentage of the total operating expenses, that the saving in fuel would amount to, (about) 6.5 per cent.

THE "STANDARD" AIRBRAKE APPARATUS.

THE tendency of electric railroading is towards constantly higher speed, and all the electric equipment of street railway cars has gradually been brought to a condition with this end kept steadily in mind. But while high speed is desireable in many ways, it introduces danger from accidents to persons and damage to property which statistics have shown to have multiplied enormously since the adoption of electricity as a substitute for the horse. The reason for this will be readily seen by a glance at the following table, showing the distance in feet traveled by a car at various rates of speeds. A fraction of a second lost in the application of the brakes may thus mean life or death:

Miles per hour.	Feet per second.
6	8.8
8	11.7
10	14.6
15	22.0
20	29.3

When it is considered that in addition to the higher speed at which they are run, electric cars frequently weigh three to four times as much as the old horse car, and that the latter had the advantage of ten feet, occupied by the horses, it is not surprising that the hand brake has been found entirely inadequate to cope with the new order of affairs, and that some form of mechanical brake must inevitably be used to secure that reasonable safety which the public has a right to demand.

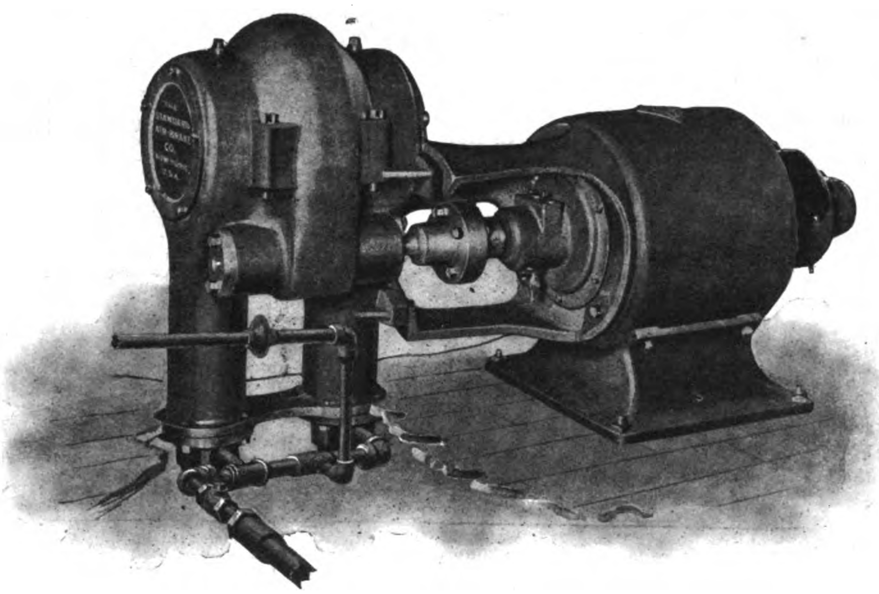
Theoretically, of course, there is a minimum limit within which cars of a given weight and velocity can be brought to a standstill, even with the most efficient brakes that can be devised. This limit is determined by the adhesion between the wheels and the rails, which at its maximum is about one-quarter of the weight resting on the wheels.

A still more important factor in braking is the manner in which the brakes are applied, due to the fact that with a given brake pressure, the braking effect is less at high speeds than at lower speeds; consequently a much higher pressure may then be applied without danger of skidding.

The airbrake is acknowledged to be the best adapted of all forms of brakes, in the application of the above facts, and among the first, if not the very first, to undertake the solution of the problem of street car braking was the Standard Air Brake Company, and in their catalogue, about to be issued, they describe in an admirable manner the latest improvements

in their system. These embrace nearly every detail of the braking apparatus, the latest arrangement of which for city street railway traffic is well shown in the insert in our advertising pages.

One of the most important details of the braking apparatus is the air compressor. The great desideratum in its working is that the power expended should cease the moment the desired pressure is attained in the reservoir. This is accomplished in the Standard brake, as follows: As long as the air has not reached the set pressure to be carried, the compressor forces air through the discharge-valve direct to the reservoirs, and continues to do so until the desired pressure is reached. The pressure will then open the regulator-valve and admit air into the governing chest under the diaphragm, forcing upwards the governing-piston and lifting the suction-valve from its seat. This opens the air-cylinder and allows the compressor-piston to move in free air and do no work, until by application of air to the brake-cylinder, the pressure is reduced. This, acting upon the regulator, releases the air confined under the diaphragm, and allows the governing-piston to fall, reseats the valve, and the compressor resumes furnishing the pressure. In making a stop, only one or two pounds registered pressure is required, and this the compressor furnishes again before the car has traveled thirty feet, although the reservoirs hold in reserve ten times the amount of air required to stop the car, even without additional supply. The air-pressure is thus practically inexhaustible.



"Standard" Electric Air Compressor for Interurban Roads.

For city traffic the Standard Company has designed a geared axle type of compressor and the gearless electric compressor shown on the insert above referred to, which runs almost absolutely without noise. The accompanying engraving shows the motor-compressor design for interurban roads. As will be seen, all its parts are enclosed in dust-tight covers. In both the city and interurban types the motors driving the compressor are provided with automatic regulating apparatus, which throws the motor into action as soon as the pressure is reduced below its proper limit, and stops it as soon as the proper pressure is obtained. Thus the motor does no work except at times actually required.

Among other improvements made in the Standard system is that effected in the controlling apparatus. This now consists of a special interlocking handle, which, when withdrawn by the motorman, leaves the brake-valve closed, so that the apparatus cannot be tampered with by mischievous passengers.

We might enumerate many other details of like character, but the above will suffice to indicate the perfection to which electric car brakes have been brought in a comparatively short time. The Standard Air Brake Company's catalogue is a masterpiece in its way, not the least of its merits being its comprehensive index.

WHAT A BROKEN POLE DID.

A remarkable accident occurred recently to the Santa Fé train running from Santa Monica to Los Angeles. The locomotive struck a cow and the animal was thrown with great force against a telegraph pole a few feet from the track, breaking it. The broken pole fell toward the train, striking a car and crashing through the windows. Some of the passengers had a narrow escape from being cut by flying glass. The pole hit a brakeman, just missing his head. He escaped with ugly bruises.

A MOTOCYCLE FESTIVAL IN RHODE ISLAND.

Next September, at Narragansett Park, Providence, under the management of the Rhode Island State Fair Association, of which Mr. F. E. Perkins is President, a five days' motocycle exhibition will be given, with the accompaniment of races. No less than $5,000 is offered in prizes, and the conditions are to be drawn up very carefully so as to benefit the new art and industry as directly as possible. The races will take place on a track seventy-two feet wide, one mile in length, within grounds sixty-seven acres in extent. Last year the association spent $85,000, and its fair had an attendance of over 125,000 people.

MASSACHUSETTS TROLLEY SYSTEMS.

Robert H. Derrah, secretary to President Little, of the West End Street Railway Company, of Boston, has prepared an interesting map showing the extent of street railway in Massachusetts. Very few people understand that a continuous journey can be made from Gloucester, Mass., or Nashua, N. H., on street railway lines, not only to Boston, but through Boston to Brockton, and with the completion of lines proposed through Bridgewater to Taunton, to Fall River and Fairhaven upon the south shore of Massachusetts. The trolley lines also extend southwest to Milford, only a few miles from the eastern terminus of the Worcester street railway, now ending in Grafton, and with this gap filled a continuous trip can be made from Boston to Spencer.

Development on account of the electric road has been pretty extensive around Braintree and Brockton upon the south and Woburn, Wakefield and Beverly on the north. The valley of the Connecticut River has also developed a considerable trolley system of its own.

LITERATURE.

"SHOP KINKS AND MACHINE SHOP CHAT," by Robert Grimshaw, M. E. New York, 1896, N. W. Henley & Co. 393 pp., 5 x 8. Price $2.50.

This work, illustrated by over 222 engravings, is written in Dr. Grimshaw's best style. There is hardly any labor-saving "kink" which has escaped Dr. Grimshaw during his visits to the best machine shops in the country, and the work ought to be as valuable to the amateur as it must undoubtedly prove to the owner of a machine shop. We must commend the very full index which accompanies the work.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS ISSUED APRIL 21, 1896.

Alarms and Signals:—

ELECTRIC GUEST CALL. S. K. Gimbel, Vincennes, Ind., 558,555. Filed Dec. 12, 1895.
Details of construction.

ELECTRIC ALARM SYSTEM. C. A. Rolfe, Chicago, Ill., 558,564. Filed Sept. 24, 1894.
Employs an auxiliary circuit for operating signal transmitting mechanism.

RAILWAY SIGNAL. W. G. Roome, Jersey City, N. J., 558,566. Filed Nov. 17, 1893.
Similar to above.

RAILWAY SIGNAL. W. G. Roome, Jersey City, N. J., 558,565. Filed Nov. 17, 1893.
Employs a main circuit comprising all the signals and a track circuit, in which the rails of one of the track sections is comprised.

ELECTRIC SIGNAL FOR RAILWAY TRAINS. E. J. Devine, Schreiber, Canada, 558,602. Filed July 25, 1895.
For description see The Electrical Engineer.

RAILWAY BLOCK SIGNAL. F. C. Stevens and J. Donovan, Lowell, Mass., 558,858. Filed Aug. 20, 1895.
Signal setting devices adapted to be actuated by the passing train, and an electric lock adapted to release said devices when the train passes from the block.

Storage Batteries:—

METHOD OF MANUFACTURING ELECTRODES FOR SECONDARY BATTERIES. I. Kitsée, Philadelphia, Pa., 558,692. Filed Nov. 8, 1894.
Consists in changing an electrolytically deposited lead surface through the action of heat in the presence of oxygen-containing material into a low oxide.

Conductors, Conduits and Insulators:—

WIRE CLAMP FOR TELEGRAPH OR SIMILAR WIRES. G. Middleton, Kirkwood, N. J., 558,509. Filed July 31, 1895.
Embodies a cam lever for tightening.

FASTENING INSULATOR BRACKETS. L. S. Beardsley, Naugatuck, Conn., 558,758. Filed Oct. 30, 1895.
A main portion, having its upper end screw-threaded for the reception of the insulator hood, and its lower end formed with lugs.

Dynamos and Motors:—

AUTOMATIC GOVERNING DEVICE FOR MOTORS. B. F. Merritt, Newark, N. J., and J. M. Joy, New York, 558,507. Filed June 29, 1895.
Provides means by which an electric motor may be started automatically and stopped by the depression and release of a key at a distance from the motor.

Electro-Metallurgy:—

APPARATUS FOR ELECTRICALLY WORKING AND WELDING COPPER. G. D. Burton, Boston, Mass., 558,480. Filed Aug. 11, 1893.
The conductors are connected to a converter and the electrodes are arranged to bear upon the bar to be treated.

Lamps and Appurtenances:—

APPARATUS FOR DETACHING ELECTRIC LAMP BULBS. O. Smith, Detroit, Mich., 558,573. Filed Oct. 7, 1895.
A flexible shaft provided with means for engaging the lamp, and means for rotating the shaft.

DROP LIGHT ELECTROLIER. G. Peeples, Philadelphia, Pa., 558,609. Filed Dec. 24, 1894.
An extensible bar or tube, adapted to slide within the central main tube of the electrolier.

ELECTRIC GLOW LAMP. E. A. Colby, Newark, N. J., 558,634. Filed May 21, 1894.
Obviates the use of supports for the inducing coil.

ELECTRIC STAND LAMP. R. Graves, Irvington, N. Y., 558,727. Filed Feb. 25, 1896.
Is intended to represent a candle or candelabra such as is usually employed on dining room tables.

ELECTROLIER. August Heck, Philadelphia, Pa., 558,904. Filed June 25, 1895.
Comprises a stand for table use.

Measurement:—

ELECTRIC METERING SYSTEM. J. W. Gibboney, Lynn, Mass., 558,585. Filed March 6, 1895.
A summation register adapted to separately add the units of meters after each unit is recorded.

Miscellaneous:—

CORE FOR ELECTROMAGNETS. A. G. Waterhouse, Hartford, Conn., 558,539. Filed Oct. 16, 1894.
Consists of a curved or annular magnet core, composed of ribbons or comparatively thin strips of iron rolled on one edge.

ELECTRIC HEATING. C. S. Bradley, Avon, N. Y., 558,714. Filed Aug. 22, 1891.
A conduit for leading the fresh air to the heater, a pipe for discharging it into an apartment, a pipe for discharging the air from the apartment over the walls of the conduit, by the means of two blowers.

PROCESS OF ELECTRICALLY TREATING FABRICS FOR WATERPROOFING OR OTHER PURPOSES. H. L. Brevoort, Brooklyn, N. Y., 558,717. Filed July 1, 1890.
Subjects the fibers to electrolytic action.

ART OF FIXING DYES IN FABRICS. H. L. Brevoort, Brooklyn, N. Y., 558,718. Filed July 25, 1890.
Consists in fixing dyes in fabrics by the use of metal oxides electrolytically deposited on the colored fibers.

ELECTRICALLY CONTROLLED GAS ENGINE OR MOTOR. G. L. Thomas, Montclair, N. J., 558,749. Filed Nov. 11, 1895.

Railways and Appliances:—

ELECTRIC STREET CAR MOTOR. S. Harris Cleveland, O., 558,491. Filed Feb. 10, 1896.
Each of the field coils is separately detachable with its core from the motor body and the body is separable in the plane of the armature shaft.

TROLLEY. J. H. Rabbitt, Wethersfield, Conn., 558,741. Filed Oct. 10, 1895.
A bar which is centrally pivoted to the free end of the trolley pole, and two contact wheels, which are respectively pivoted to the opposite ends of said bar.

MEANS FOR REVERSING TROLLEY POLE SUPPORTS. H. P. Wellman, Ashland, Ky., 558,868. Filed Sept. 17, 1895.
Employs pneumatic pressure.

TROLLEY FOR ELECTRIC RAILWAY CARS. H. P. Wellman, Ashland, Ky., 558,869. Filed Oct. 1, 1895.
Provides for the automatic lowering of the trolley pole immediately after the wheel jumps the wire.

ELECTRIC RAILWAY CAR. H. P. Wellman, Ashland, Ky., 558,870. Filed Nov. 5, 1895.
Similar to above.

Regulation:—

REGULATOR FOR ELECTRIC MOTORS. O. H. Pieper, Rochester, N. Y., 558,517. Filed Jan. 20, 1896.
The combination with a shunt wound motor, of a resistance in series with the field magnets, a resistance in series with the armature, and a branch containing a variable resistance between corresponding conductors of the field and armature.

ELECTRIC RHEOSTAT OR HEATER. H. W. Leonard, East Orange, N. J., 558,559. Filed Dec. 18, 1895.
Employs enamel for insulating the conductor and attaching it to the support.

MEANS FOR CONTROLLING ELECTRIC CURRENTS. P. Kennedy, Brooklyn, N. Y., 558,650. Filed June 27, 1895.
Especially designed for use in connection with dynamos employed to operate the lamps upon railroad trains.

Switches, Cut-Outs, etc.

HANDLE FOR CIRCUIT BREAKERS. W. B. Potter, Schenectady, N. Y., 558,518. Filed Jan. 15, 1896.
An interchangeable handle removable when the circuit is open.

APPARATUS FOR OPERATING ELECTRIC SWITCHES. D. Hinchliffe and A. D. Ades, Plymouth, Mass., 558,687. Filed May 15, 1895.
Means for operating a switch by push buttons placed in any part of a building.

MULTIPLE CONTACT SWITCH. E. H. Wright, Chicago, Ill., 558,750. Filed Nov. 28, 1894.
Adapted for use on three-wire systems.

Telegraphs:—

PRINTING TELEGRAPH. B. F. Merritt, Newark, N. J., and J. M. Joy, New York, 558,506. Filed June 29, 1895.
Consists in mounting the type wheel carriage on rollers and journaling the type wheel and the worm on this carriage.

TELEGRAPH KEY. W. E. Simons, Dublin, Canada, 558,617. Filed Sept. 12, 1895.
Means for insuring the closure of a telegraph key when the same is not in use.

RELAY. F. E. Chapman, Medford, Mass., 558,672. Filed Jan. 27, 1896.
Employs the current in one winding of an induction coil to magnetize the armature and the induced current of secondary winding of the coil to move the armature.

Telephones:—

TELEPHONE. S. D. Field, Stockbridge, Mass., 558,584. Filed Aug. 24, 1895.
For description see The Electrical Engineer, April 29.

TELEPHONE TRUNK CIRCUIT. W. H. Hennessey, Chicago, Ill., 558,686. Filed Feb. 7, 1896.
For long distance use.

TELEPHONE APPARATUS. A. Stromberg and A. Carlson, Chicago, Ill., 558,859. Filed Oct. 9, 1894.
Details of construction.

LEGAL NOTES.

OTTO GAS ENGINE PATENTS.

The Otto Gas Engine Works of Philadelphia have issued the following notice:

We think it fair to you, as well as to ourselves, to advise you that we are informed by our counsel, Messrs. Baldwin, Davidson & Wight, of Washington and New York, that the electrical igniter on the gas and gasoline engines of the New Era Iron Works Company is an infringement of Letters Patent of the United States, No. 525,828, granted September 11, 1894, to Mr. Paul A. N. Winand, and of which we are the owners. We have brought suit in the Southern District of Ohio against the New Era Iron Works Company and propose to protect our rights against all makers and sellers or users of engines having upon them igniters covered by such Letters Patent.

THE NATIONAL CONDUIT MANUFACTURING CO. SUSTAINS ITS PATENTS IN THE COURTS.

A decision was rendered recently by Judge Townsend, in the United States Court, District of Connecticut, sustaining the patents of the National Conduit Manufacturing Company in their suit against the Connecticut Pipe Manufacturing Company. The decision enjoined the Connecticut company from infringing the patents on the well-known cement-lined tubes, which patents are owned and controlled by the National Conduit Manufacturing Company.

Last week Judge Townsend, on the application of the Connecticut Pipe Manufacturing Company, decided to reopen the case, and we learn that, pending final decision, the latter company will continue the manufacture of cement-lined pipe as heretofore.

Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

THE MANHATTAN INCLOSED ARC LAMP.

THE Manhattan inclosed arc lamp has been commercially on the market for one year and a half, during which time the Manhattan General Construction Company gradually built up the reputation of inclosed arc lamps to such a degree that the principle of inclosed arc lamps is now acknowledged to be correct.

Since starting the company have placed in service up to the present time about 7,000 Manhattan lamps, and have had the lamp adopted by 100 direct current central stations. Of course, the adoption of the lamp by all of these companies was after thorough tests under every possible condition of service, and the growth of the business is extending month by month.

The main features of the Manhattan lamp—which is illustrated in the accompanying engraving—outside of saving in operating are, first, the possibility of drawing an arc at 80 volts, making it possible to burn lamps singly, instead of two in series, as was necessary with open air arc lamps. The advantage of each lamp being an independent unit, will, without doubt, do much toward extending the use of incandescent arc lamps in all kinds of service. The arc being inclosed within two practically air tight globes prevents the throwing out of sparks and carbon dust, and makes the lamp particularly desirable from the underwriter's standpoint.

THE MANHATTAN INCLOSED ARC LAMP.

Perhaps the most attractive feature of the inclosed arc lamp is the diffusion of light obtained by the use of the double opalescent globes. The inner globe diffuses the light on the outer globe and removes absolutely all shadow from the outer globe as well as beneath and above the lamp, and makes a space lit with Manhattan lamps a perfectly uniform light, and the long arc eliminates all the yellow rays, and produces an effect nearer to true daylight than any artificial light that has yet been offered.

The inclosed arc at once necessitated an entire new style of mechanism. The mechanism of the Manhattan lamp has done away with all clockwork, carbon rods, dash pots, and the like, and is nothing but a solenoid with an armature and simple ring clutch. The carbon feeds direct without the intervention of a carbon rod, which in addition to overcoming the difficulties incident to a carbon rod, allows of the shortest arc lamp that has ever been put on the market. The Manhattan "Standard" lamp, using 12-inch upper and 5-inch lower carbon is only 37 inches long, while their "Junior" type of lamp, using 12-inch upper and 5-inch lower carbon, is only 23 inches long over all.

In regard to the matter of saving of carbons; after burning for 150 hours there is sufficient left of the upper carbon to use for a lower carbon for the next run, so that on the basis of 10 hours per day the cost of carbons for one year with the Manhattan lamp (at $25 per 1,000 12-inch carbons) will not exceed 50 cents per lamp per year, whereas in commercial work where the average burning of lamps is less than 4 hours per day, the lamp will only require for 300 days service about 8 carbons per year or 16 cents per lamp per year for carbons.

In regard to saving in labor, it is, of course, governed by the service in which the lamps are used, and their distribution. Theoretically, there would be almost the same proportionate saving in labor as in carbons, but in practice it is found the saving on the average is about two-thirds, so that the saving on commercial and street lighting service might be given at from $10 to $15 per lamp per year as a minimum.

The best figures in the way of verification in the above deductions from the Manhattan Company's experience are as follows: The Brooklyn Edison Company have made up figures on the saving from 350 Manhattan lamps which they use in street lighting service, and they report a saving of about $15 per lamp per year, although this saving shows somewhat in the lamp's favor for the reason that 100 of the Manhattan lamps displaced twin street lamps, taking, of course, more carbons, although smaller than the single lamps.

The Boston Edison Company have 200 Manhattan lamps in commercial service. They report an average burning of 3.64 hours per lamp per day, and figure a saving from between $11 to $12 per lamp per year.

Profs. Houston and Kennelly have made a test on the candle power of the Manhattan lamp, and also examined the diffusion of light. These show that the long arc in the Manhattan lamp changes considerably the old formulas of taking all measurements at an angle of 40 deg. below the horizontal. In the column of luminous intensity, we note that the maximum angle of light is about 25 deg. and that it then drops off and rises again at about 45 deg. This was caused by the curve on the inner globe used at the time of this test, but the shape of the inner globe has since been changed so that the curve of the angle of light is now practically uniform from 25 to 60 deg., thus giving a diffusion of light over a very extensive radius.

It might be well to add a word in regard to the efficiency of the inclosed arc lamp, as many seem to not be able to figure correctly and comparatively between the inclosed arc lamp burning singly and the ordinary open arc lamp burning two in series, on account of the fact that the inclosed arc lamp takes only one half the current of the two in series lamp. With Manhattan lamp on a 110 volt circuit, there is a permanent resistance taking up from 28 to 30 volts, which at 5 amperes makes 140 to 150 watts consumed in the resistance. In open air arcs there is a permanent resistance absorbing 13 to 15 volts in each of the pair of lamps running at 10 amperes, or there is consumed in the resistance from 260 to 300 watts for the pair, or 130 to 150 watts to each lamp, so that it will be seen that the efficiency of inclosed and open air arc lamps is practically the same.

One of the main features of the Manhattan lamp is the fact that there are employed double globes, both of which are practically tight. The outer globe being entirely inclosed, of course, acts as a thorough protection against weather, but in addition the outer globe acts as a storage chamber for the inner globe or chamber of high rarefaction, and makes the egress of air containing oxygen into the inner globe and to the carbons, very slow.

THE ELECTROSE MANUFACTURING COMPANY, now situated at 216 William street, New York, are again compelled to seek larger quarters, owing to the constantly increasing demand for their wares, and will remove May 1 to 127-137 North Tenth street, Brooklyn, N. Y. They will have there some 13,000 square feet of floor space, and with a larger plant will be in position to meet promptly all calls for the substitute for hard rubber.

THE Government of Japan, Department of Communication, has written to the Standard Air Brake Company, requesting that company's literature.

FAN MOTORS are the subject of Catalogue No. 16, just issued by that brainy and pushing concern, the Central Electric Company, of Chicago. It is full of cuts and data.

THE AMERICAN ELECTRIC VULCANIZER.

THE bicycle has called into life a multitude of devices designed either for the ease and comfort of the rider or as auxiliaries in effecting repairs. The rubber tire is perhaps the most vulnerable part of the machine, and damage to it has in the past usually demanded a new tire. Thanks to the introduction of electrical heating devices this is no longer necessary. The electric vulcanizers which are shown in the

FIG. 1.—THE "AMERICAN" ELECTRIC VULCANIZER.

accompanying engravings, which are the latest designs of the American Electric Heating Corporation, of Boston, puts it within the power of any ordinary repair shop to put a punctured or ruptured bicycle tire in a condition practically as good as new.

As will be seen, the machine may be set up on any substantial table or work bench, and a space of two by three feet is ample. The tire is clamped to the plate of the vulcanizer under a pressure of about fifteen pounds, and the illustrations show the different methods by which this is accomplished. Several tires can be repaired at one time. The temperature of the plate is controlled by a rheostat or switchboard on the end of the machine, the heat being applied by turning the switch to the

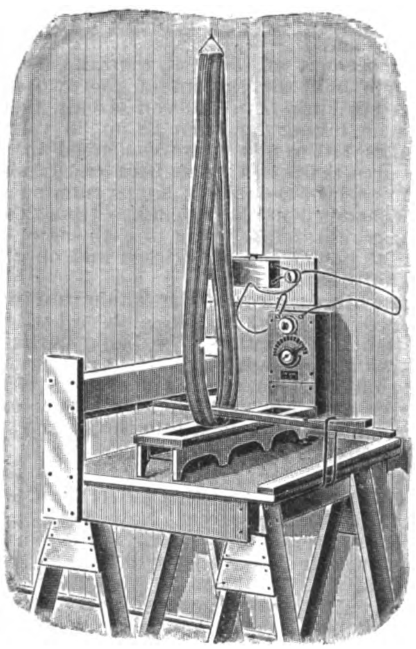


FIG. 2.—THE "AMERICAN" ELECTRIC VULCANIZER.

right, and each successive turn from left to right increases the amount of heat applied to the plate. The proper temperature can be determined accurately by curing a piece of uncured rubber.

These vulcanizers are made in two sizes, the smaller, type A, Fig. 1, suitable for the average repair shop, and type B, Fig. 2, with two plates, adapted specially for larger repair shops.

KENSINGTON FEED WATER HEATER AND PURIFIER AT THE PHILADELPHIA BOURSE.

IN the engravings on this page we present two views of a feed-water heater and purifier furnished by the Kensington Engine Works, Limited, Francis Brothers, Philadelphia,

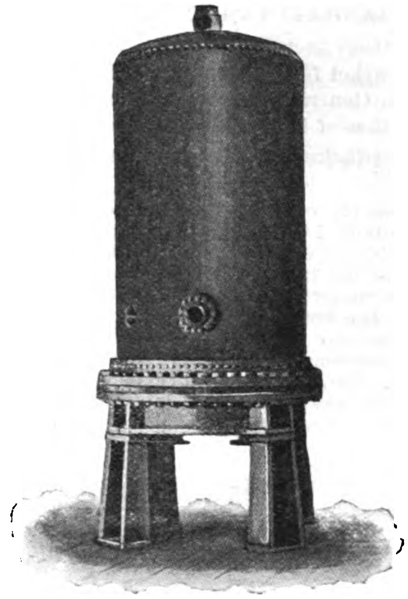


FIG. 1.—THE KENSINGTON FEED WATER HEATRER.

Pa., for the recently completed Philadelphia Bourse. It is attracting considerable attention from visitors viewing the mechanical exhibition in the Bourse as furnished by the machinery used in the building.

About 18,000 square feet of space is occupied in the basement by the machinery equipment, and the chief interest centers in the power and heating plants, of which this heater, probably one of the largest in diameter ever built, is an important factor. The heater is 60 inches in diameter, with shell 14 feet high over all, and has exhaust steam inlets and outlets 16 inches diameter. It is provided with 350 square feet of heating surface and heats the feed-water used in the boiler

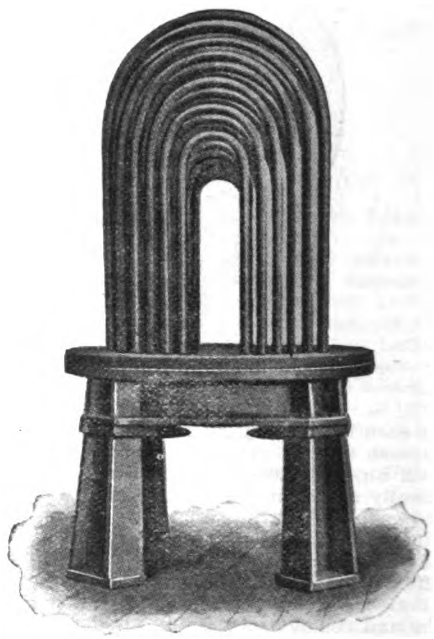


FIG. 2.—THE KENSINGTON FEED WATER HEATER.

supply to 206 deg. by the exhaust steam from the electric light engines and pumps, while also purifying it.

The heater is of the reservoir type, return tubular, and has a capacity of 1,250 gallons. The exhaust enters at the bottom, and, passing through the tubes on one side, returns through the tubes on the opposite side, while the feed-water

is in the shell surrounding the tubes, thus absorbing rapidly the heat in the exhaust steam.

While the general construction of this heater is largely explained by the engravings, a few words regarding the details are of interest. There is first a cast iron base with projecting flanges on the top and suitable flanged nozzles on the bottom for the ingress and egress of the steam, and projections properly ribbed and braced are also provided for the reception and bolting to of the four cast iron legs which support the heater at a suitable height from the floor.

Resting upon the top flange of the bottom casting is the tube head made of semi-steel, similar to that used by the Cramps in guns, which is made convex in order the better to withstand and resist the pressure required to force the water into the boiler, which is 125 pounds per square inch.

The tubes, which are of seamless brass and therefore free from corrosion and very durable, are securely expanded into this tube head, and when so done the tube and tube head becomes practically one piece or part of the apparatus.

The shell, which is of wrought steel ½ inch thick, is designed to inclose the tubes and at the bottom end has a strong cast ring securely riveted to it, with projecting flange corresponding in diameter to the flange of bottom casting and tube head. The bolt holes of all three being identical in the matter of spacing and pitch circle, one set of bolts, with proper gaskets intervening, the whole three parts of the heater are firmly bolted together.

Feed-water enters and leaves the heater by a 4½-inch pipe, and all impure deposit is blown out through a 3-inch mud blow at the bottom, while the impurities which float on the surface are removed through a 2½-inch surface blow. The connections provided are shown as located on the shell in Fig. 1.

A feed-water heater of the same diameter and general construction is installed by the Kensington Engine Works, Limited, in the power plant of the Broad street station, Philadelphia, where it has given most safisfactory results.

THE NORTHERN ELECTRICAL MFG. CO'S MOTORS.

AMONG the recent additions to the types of dynamo electric machinery are the motors of the Northern Electrical Manufacturing Company, of Madison, Wis. These machines are inclosed in very strong, steel spheres without joints so that attachment may be made of the motor to any other machine in almost any conceivable position and have as firm connection as though attachment were made from the base of the machine as is ordinarily done. The machines can be used with or without bases; they are so constructed in their bearings that they run as well upside down, fastened to the ceiling; or half inverted bolted to a post or side wall, thus saving the floor space which would ordinarily be occupied by the motor. It makes no difference what direction the draught of the belt is from, the bearings work equally as well.

That feature of the machine which enables it to be inverted renders it a very convenient machine for direct attachment to line shafts, the motor being inverted and bolted up to the ceiling in the same position as an ordinary hanger. A line shaft, or main shaft of any particular machine, may be directly connected to the motor shaft. The Northern Company also have a geared attachment to be used in some cases where the direct shaft attachment may not be practicable.

The company are making a specialty of motors, dynamos and electric hoists, to which they confine themselves exclusively.

STANDARD TELEPHONE CABLES.

The very satisfactory results which may be attained by earnest and systematic efforts to improve the quality of the manufactured article is strikingly illustrated by the character of the cables furnished by the Standard Underground Cable Company at the present time for telephone use.

A recent large order for the American Telephone and Telegraph Company, of Providence, was sold with a guarantee of 500 megohms per mile insulation resistance, and a capacity of .08 microfarad per mile. The tests of these cables by the electrician of the Providence company disclose the remarkably low average capacity of .0743 and .0749 microfarad per mile. The highest capacity of any wire in the cable was .0776, and the lowest .0716, showing a high degree of uniformity. The insulation resistance of the wires averaged 1,933 megohms and 3,300 megohms per mile, respectively.

The Standard Underground Cable Company, as well as the American Telephone and Telegraph Company, are certainly to be congratulated on this truly remarkable showing.

MESSRS. HERRICK & BURKE, consulting engineers, have removed their offices to the American Tract Society Building, No. 150 Nassau street, New York, where they will have increased facilities for carrying on their work.

THE HELIOS ALTERNATING LAMP WIRING TABLE.

WIRING tables for incandescent lamps have been current for years, but, strange to say, arc-lamp wiring seems to have been entirely neglected. It must be evident, however, that when it comes to installations of arc lamps on constant potential circuits involving anywhere from a dozen to one hundred or more arc lamps, some system is necessary to

TABLE OF WIRES

For Helios Alternating Arc Lamps, from 30 Volt Transformer and Economy Coil Service.

Ampere Delivery of Transformer or Coil.	Distance in feet from Transformer or Economy Coil to last lamp on Circuit. Expressed on loss of 5 per cent. or drop of 1.5 volts.																	
	15	25	30	40	50	60	75	80	90	100	120	130	140	150	160	175	190	200
10	14	14	12	12	10	10	8	8	8	8	8	6	6	6	4	4	4	2
12	14	14	12	10	10	10	8	8	8	8	6	6	6	6	4	4	2	2
16	14	12	10	10	8	8	8	8	8	6	6	6	6	4	4	2	2	2
20	12	12	10	8	8	8	8	8	6	6	6	4	4	4	4	2	2	2
24	12	10	8	8	8	8	8	6	6	6	6	4	4	4	2	2	2	0
28	10	10	8	8	8	8	8	6	6	6	4	4	4	2	2	2	0	0
32	10	8	8	8	8	6	6	6	6	4	4	4	2	2	2	0	0	0
36	8	8	8	8	6	6	6	6	4	4	4	2	2	2	0	0	0	00
38	8	8	8	6	6	6	6	4	4	4	4	2	2	0	0	0	00	00
40	8	6	6	6	6	6	4	4	4	4	2	2	0	0	0	0	00	
46	8	6	6	6	4	4	4	4	4	2	2	0	0	0	0	00		
50	6	6	6	4	4	4	4	2	2	2	2	0	0	0	00	00		
60	6	4	4	4	4	4	2	2	2	2	0	0	0	00	00			
75	6	4	4	4	2	2	2	2	0	0	0	0	0	00	00			
85	4	4	4	2	2	2	2	2	0	0	0	0	00	00				
100	4	4	2	2	2	2	2	0	0	0	0	00	00	00				

obtain economy in wiring. The Helios Electric Company, of Philadelphia, have therefore done the electric fraternity a good service in compiling a table specially covering the wiring of alternating current arc lamps. The table which we reproduce herewith is calculated on a 30-volt basis, but can, of course, be readily converted to any other basis by introducing the proper multiplier.

NEW WESTERN ELECTRIC FACTORIES.

The Western Electric Company have just completed a new factory in Chicago at a cost of $125,000, and are preparing to build another to cost an equal amount.

The structure nearly completed extends from No. 242 to No. 248 Jefferson street, and is 180 feet front by 50 deep. It is regarded as one of the most completely fireproof manufacturing buildings in Chicago. With metal partitions and steel construction throughout it is practically beyond the reach of flames. Not a particle of wood his been used in the construction, excepting for finishing. The building is equipped with automatic sprinklers. A novel feature is the use of numerous bays on the west side, giving ample light for the workmen and following the lines of the most sanitary manufacturing buildings.

The proposed building, for which plans are being prepared, will correspond in its general construction with the building recently completed. It will take the place of a number of old buildings in the center of the company's plant, and will be 50 x 100 feet, with two wings 40 x 60 feet.

In this structure will be placed the boilers and engines, which will provide power for the entire plant. A new system of electrical power transmission with individual motors for the different rooms is being placed in all the buildings of the plant, and will save much of the energy wasted in the transmission of power by heavy shafting. Work on the building, for which Treat & Folz are making the plans, will be commenced in the summer.

CHANGES IN STANDARD UNDERGROUND PERSONNEL.

As stated in our former numbers, the Standard Underground Cable Company have been making a number of changes in the personnel of their home office, in order to handle the large increase in their business. Mr. Frank C. Cosby, formerly of the engineering staff of the Westinghouse Electric and Manufacturing Company, at Pittsburg, has taken the place left vacant by Mr. F. S. Viele's transference to Pittsburg, and goes to Chicago as superintendent of construction. Mr. Cosby graduated from Cornell University as an electrical engineer in 1893, and has since been actively employed in electrical work, and during the World's Fair was electrician to the U. S. naval exhibit on the model battleship "Illinois." He will prove an able assistant to Manager J. R. Wiley in taking care of the constantly increasing business of the Standard Underground Cable Company in this territory.

Mr. Cosby has just returned from Columbus, Ohio, where the Standard is installing the underground cable system for the Central Union Telephone Company.

MR. JAMES McLAUGHLIN, recently with the Philadelphia Engineering Works, Limited, has been elected secretary and treasurer of the Barr Pumping Engine Company, of Philadelphia. Mr. W. W. Lindsay is the General Manager of the latter concern.

FISHER AND CRAMPHORN.

This is the name of a new company who are going to manufacture electrical specialties at 355 Congress street, Boston, Mass., the old factory of the Consolidated Electric Manufacturing Company, which company was absorbed by the Walker Company, of Cleveland, a few weeks ago. Messrs. Fisher and Cramphorn are both well known to the electrical trade, Mr. Fisher having been connected with the Consolidated Electric Manufacturing Company for many years as their factory manager, and Mr. Cramphorn having been in charge of their business department for the past few years. This company will continue to manufacture the well-known "J. K." switches and switchboards, and have the sole right to manufacture the "Lyon" brake handles, which have established for themselves an excellent reputation among street railway men. Both Messrs. Fisher and Cramphorn are well posted as to the necessities for reliable apparatus in all electrical business, and their long experience in this trade should enable them to manufacture just the class of material required, and with the numerous friends which they have made in past years, success will undoubtedly crown their efforts.

SOMETHING NEW IN JACK-KNIFE SWITCHES.

The Electric Engineering and Supply Company, of Syracuse, N. Y., are again in the field with an improved jack-knife switch, of which some of the cuts herewith give an idea of the construction of the arm. It will be noticed by careful examination of the arm that it is made in sections by a principle which the company have had patented, being something entirely new applied to electric switches. The backbone of the arm is made of brass tube slotted to receive a copper blade, held in by patent process of plugs and nuts, making a secure and strong arm, as well as securing a good flexible contact to the contact clips.

A number of these switches are already in use on some of the principal switchboards in New York City, Buffalo and other cities. The company are now building some seventy-five of these new style switches to be placed on the switchboard in the new Siegel-Cooper Building in New York City. Notable among the boards in New York City on which these switches are used are the following: One installed by the St. Nicholas Skating and Ice Company, West Sixty-sixth street; the Vance Electric Company, 65 Murray street, and Edwards & Company, southeast corner Clinton and University place. The handsome appearance of these switches is what makes them a favorite with switchboard men, as well as their unusually good adaptabilities for switchboard use, as to bus-bar connections. They are made for either back or top connections, adapted for any voltage.

THE G. E. 150 HOUR ARC LAMP.

Arc lamps for constant potential continuous circuits, designed to burn 150 hours without retrimming, and a shorter lamp of similar design to burn 100 hours without retrimming have just been announced by the General Electric Company. These lamps require about 5 amperes at 80 volts, a resistance adjustable for voltages of 150 to 120 contained in the lamp, reducing the normal voltage of a lighting circuit to that required by the lamp. The lamps are sent out adjusted for 110 volts. By confining the arc in a sealed globe an inert gas is formed, reducing the consumption of carbon and securing longer life. The mechanism of the lamp is simple, requiring no adjustment.

The color, volume and character of the light are varied by using different inner and outer globes. A dense opal inner globe and opalescent or ground glass outer globe give the effect of the glow lamp, with less volume of light, while, where the appearance of the light is not objectionable, an opalescent inner globe and a clear outer globe may be used, securing a larger volume of light.

THE WALKER MANUFACTURING CO.

That many of the large companies that manufacture electrical goods have suffered severely during the recent general depression in trade is a matter of which there cannot be any doubt. Happily there is now a brighter outlook on the business horizon and it is to be expected that the important electrical industries will be early benefited by the revival. One sign of a healthy reaction in this direction is furnished by the following list of contracts for street railway apparatus, which the Walker Manufacturing Company of Cleveland have closed quite recently: Chicago City Railway Company, five 800 kilowatt belt driven generators; Metropolitan Railway Company, Kansas City, one 1,200 kilowatt direct connected generator; Englewood and Chicago Electric Railway Company, four 250 kilowatt direct connected generators, twenty-three car equipments which will comprise a 50 h. p. motor and a Walker controller to each car; Bluff City Railway Company, Waukeegan, Ill., three double 30 h. p. equipments. These contracts were secured through the Chicago office of the company, of which the Messrs. Koehler Brothers are managers. Naturally to be expected there was quite a sharp competition for these orders, as they represent in the aggregate over 9,000 h. p., and they were all closed inside of two weeks, which is an unusually short time when the magnitude of the business is taken into account.

GENERAL MANUFACTURERS' DISPLAY BUREAU.

Messrs. Edwards Bros. & Company, of 90 and 92 West Broadway, New York, have organized "The General Manufacturers' Display Bureau" for the purpose of interesting those manufacturers located outside of New York City who are desirous of having: 1. First class representation of their product in this city. 2. Facilities for having out-of-town buyers brought in contact with a personal inspection of their products. 3. The advantage of being able to show a complete line of samples to the trade of their manufacture or output.

The firm's offices and sample rooms have been selected with great care, and are located down town, in the center of the wholesale district, convenient to every class of buyers who visit New York regularly, and seldom, if ever, have the time to go to other cities.

Each member of the firm is a first class salesman, and their acquaintance amongst the buyers of the United States, together with the facilities they have at their command for reaching them as they come to town, are unlimited. They now have over 38,000 square feet of space, combining light, ventilation, and all modern conveniences, with the option of as much more room as may be required.

QUEEN & COMPANY.

A banquet was given recently at the Manufacturers' Club, Philadelphia, by the stockholders and creditors of the celebrated old house of Queen & Company, Incorporated, as a testimonial to Mr. John G. Gray, who at the time of the panic was appointed receiver of the concern. Mr. Gray has redeemed the company and re-assigned to it the property with a generous surplus of $200,000. In the reorganized firm the officers are: J. G. Gray, president; S. L. Fox, vice-president; and J. M. Hazel, secretary and treasurer.

ELECTRICAL AND SCIENTIFIC INSTRUMENTS.

Mr. James G. Biddle, No. 944 Drexel Building, Philadelphia, is quietly but surely building up an excellent business in scientific and electrical instruments. As sales agent for the Weston Electrical Instrument Company, Mr. Biddle makes a leading specialty of the voltmeters, ammeters, and wattmeters of this standard type, and is always ready to quote prices or furnish special information regarding them. His compact illustrated Catalogue X is much in demand—containing a complete price list of Weston apparatus, and also valuable data for resistance measurements.

Mr. Biddle is also distributing agent for Messrs. Elmer G. Willyoung & Co., of Philadelphia, manufacturers of electrical test instruments and scientific apparatus. To describe their various instruments Mr. Biddle has just issued circulars No. 135, 160 and 165, which should be written for at once by interested parties.

MESSRS. C. C. SIBLEY & COMPANY, selling agents for the General Electric Company for New York City, will remove their offices on May 1 from the Postal-Telegraph Building to their new store at No. 329 Fourth avenue, between Twenty-fourth and Twenty-fifth streets. This firm has decided that in order to better serve the trade they should keep pace with the northward march of business in New York. They will carry a full line of contractors' supplies, including interior conduit, bell and annunciator supplies. They are looking forward to a big sale of Lundell fans this season and will be prepared to fill promptly all orders for them.

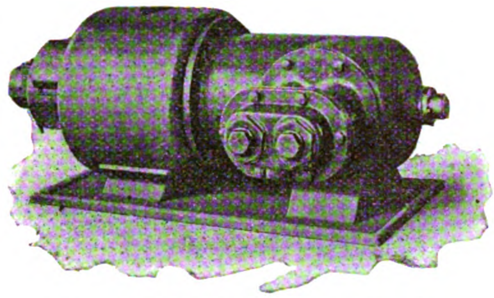
THE ABENDROTH & ROOT MANUFACTURING COMPANY, 28 Cliff street, New York City, have closed contracts for their Root improved water tube boiler for the electric light and power plant of the East River Bridge, Munsey's new building and the Electrical Exposition, New York City.

THE BALL ENGINE COMPANY, Erie, Pa., have removed their Chicago office to the Monadnock Building, Room 1526.

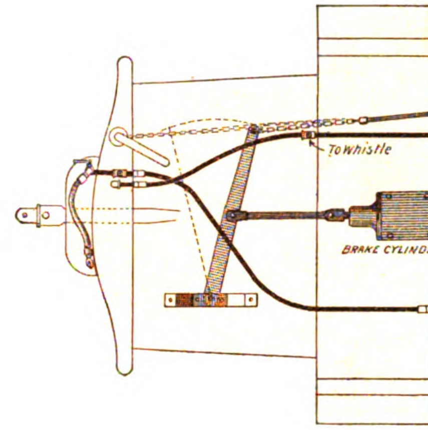
Department News Items will be found in advertising pages.

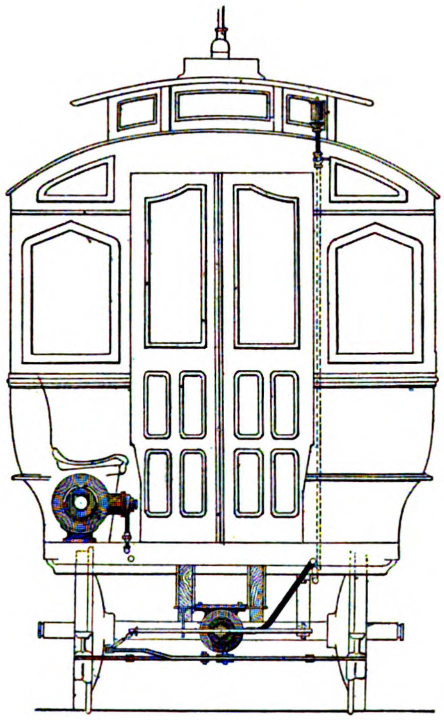
ARRANGEMENT OF THE STANDARD AIR-B

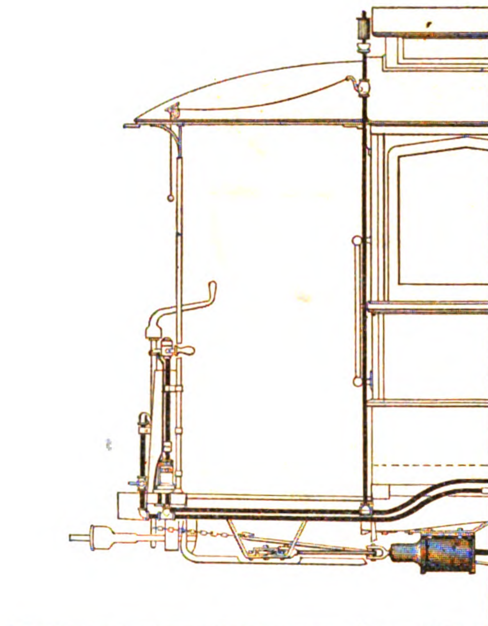
It is just as easy to equip double-truck cars with Standard Air-Brakes as it is to equip saving in wages of extra brakemen (necessary when Standard Air-Brakes are not used) soon



GEARLESS ELECTRIC COMPRESSOR.







Die Ersparung des Lohnes für diejenigen extra Bremser, welche dort nöthig sind wo die Brakes nicht angewendet werden, deckt bald völlig die Kosten dieser Air-Brakes. Anfragen w beantwortet.

Arrangement der Ausrüstung der Standard Air-Brake Co. (Motor und Zug Wagen bes Namenangabe der Theile, sowie Ansicht der direktgekuppelten electrischen Compresse.

Die Ausrüstung der doppelten Untergestelle mit Standard Air-Brakes ist ganz ebenso lei men, wie die mit einfachem Untergestelle. Bei Benutzung der Standard Air-Brakes wird d besonderer Beamten zur Handhabung der Bremsen völlig unnöthig.

Der Motor Mann hat bei Zügen welche von electrischen Locomotiven oder Motoren gez einerlei ob eine oder mehrere Maschinen in Anwendung kommen, jederzeit völlige Controlle de

RAKE COMESSOR.

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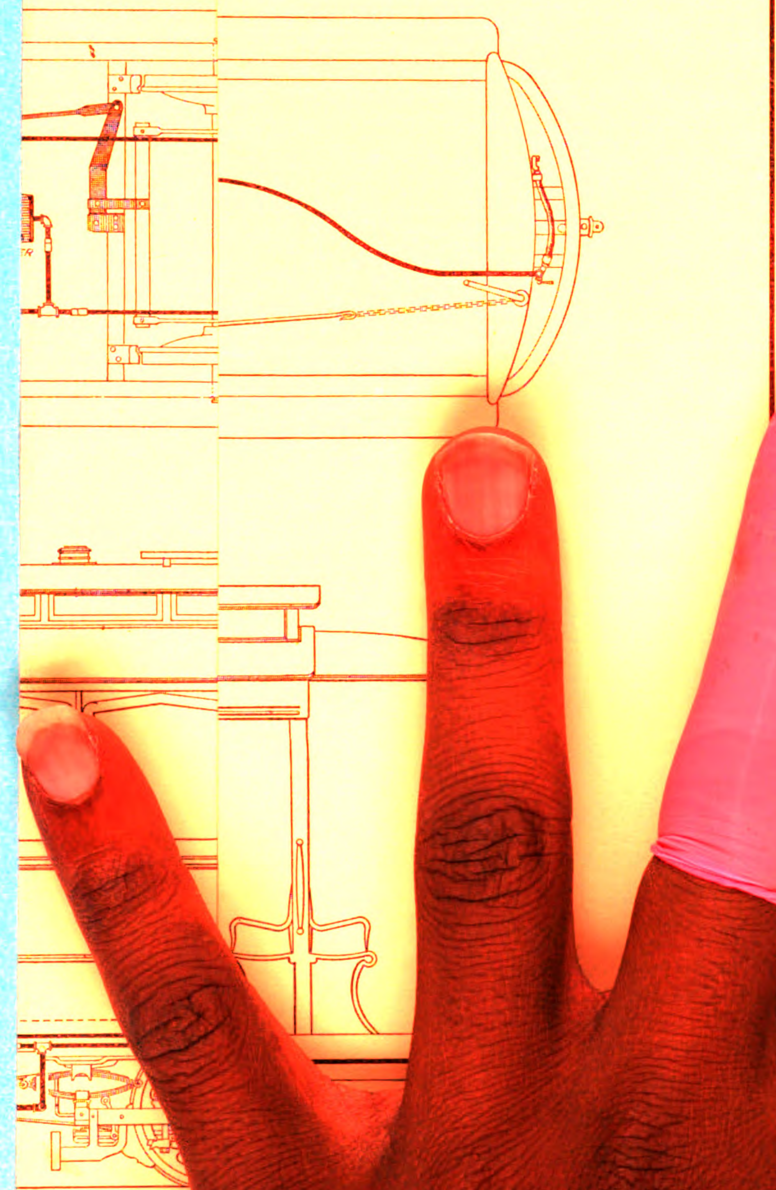

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THE

Electrical Engineer.

Vol. XXI. MAY 13, 1896. No. 419.

ELECTRIC LIGHTING.

EQUALIZER SYSTEMS OF DISTRIBUTION.[1]

BY A. CHURCHWARD.

IN preparing the following paper, the limited scope of which is indicated by its title, I have assumed that a three-wire system is supposed to be the only safe and reliable system of direct current distribution for motors and lights in our cities. It is my intention to refer to the many methods that have been devised to accomplish the results obtained by the three-wire system, without the use of a divided source of electrical energy, and a compensating conductor

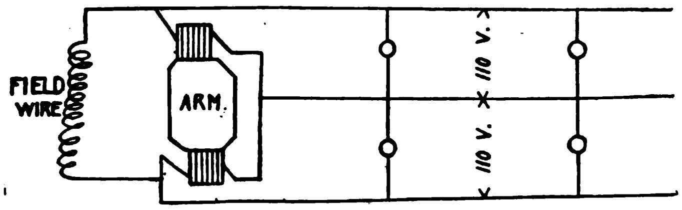

FIG. I.

connected to the point of division. I now lay before you an abbreviated list of such methods.

1. Using a single dynamo with two commutators: Very little would be gained by this even if it did not infringe the above system, as one commutator on a large machine is all most people can put up with. Fig.1.

2. I do not think that at this late day any one is likely to try the combination of a 220 volt dynamo and two sets of lamps connected in series by a third wire. Fig. 2.

3. This time we come to a true system of equalizer distribution. We have only one generator of, say, 220 volts, A, Fig. 3, and two small machines, C and D, capable of taking care of the unbalance due to turning off lights on either side of the circuit; and a motor, B, connected to the two outside mains and driving the two machines, C and D.

In this system our comparative loss is quite great at light loads, as we have a constant loss due to the friction field current, and Foucault currents of three machines. Another disadvantage is the difficulty in keeping the system properly balanced, owing to drop in speed of motor with increase of load, drop in voltage of one of the machines, C or D, when running as a dynamo (due to armature reaction and C^2R losses in the

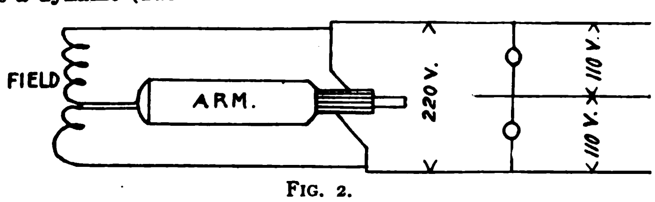

FIG. 2.

armatures); and, on the other hand, the load being taken off, the voltage will be taken off on the lightly loaded side.

The action that takes place is this, and will be found nearly the same in all equalizer systems.

When both sides of the circuits E and F are equally balanced, the motor B runs free, only taking enough current to keep C and D up to the proper e. m. f. Should the load be changed, however, so that F had 20 amperes and E 10, then there would be unbalance of 10 amperes.

An ammeter placed in the circuit at G would indicate 15 amperes plus the amount of current to run combination B, C and D. Fifteen amperes would flow from the main (F) M to N, and the machine D would act as a dynamo and supply the

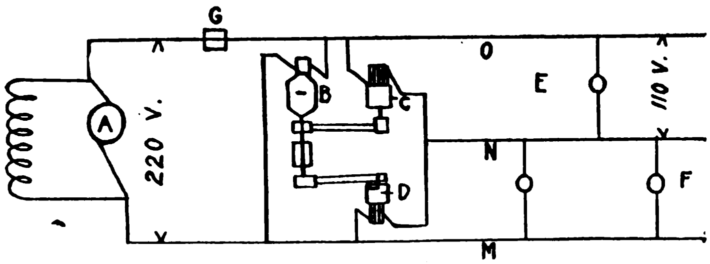

FIG. 3.

other five amperes. On the other hand, the machine C would take the five amperes from the neutral N, and run as a motor, helping to drive the motor B.

Thus it can be seen that under ordinary conditions we can dispense with the motor B and couple C and D together, as per diagram. But by using the motor B, a greater load on one side can be taken care of.

4. A single dynamo, 220 volts, A, Fig. 4, and a small machine of 110 volts, C, driven by a motor, B, connected across the 220 volt mains. The motor B drives the machine C so that the pressure across E and F are equal; should the load be

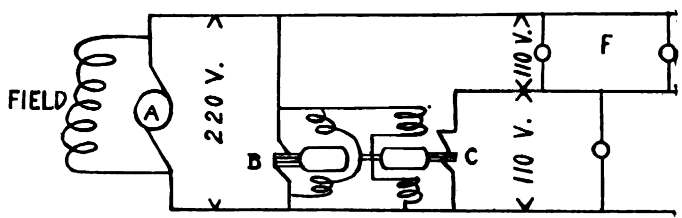

FIG. 4.

increased on E, the pressure will fall, and the machine C will supply the extra current needed to balance the pressure; if the load on E is less than on F, then C will run as a motor, driving B as a dynamo. In this case also there will be a slight unbalance of pressure, due to armature reaction, etc.

5. Still another method has been proposed. This employs a single dynamo of 220 volts. To the brushes of this machine are connected the two outside wires, the neutral wire is connected to the center of the armature coils, and this raises a potential midway between the two outside wires.

6. A system in use in central stations in Europe might

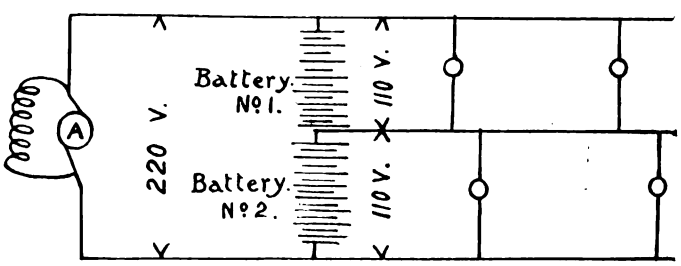

FIG. 5.

be mentioned here, but we can hardly call it an equalizer system. It consists of a 220 volt dynamo and two sets of batteries, Fig. 5. The accumulators here play the same part as their namesakes do in a system of hydraulic supply. The bat-

* Read before the N. E. L. A., New York, May 5, 6 and 7, 1896.

tery connected to the circuit that requires most current discharges into the circuit, and thus helps the dynamo; and the battery in which the demand is smaller is charged by the surplus current.

There is no economy in an installation by this method over

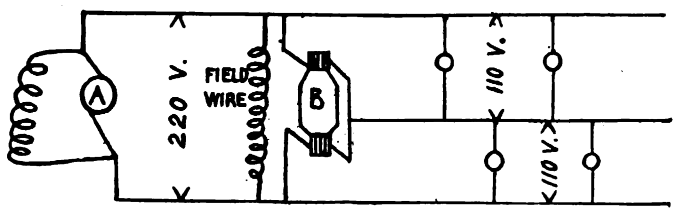

FIG. 6.

others, the accumulator costing much more than a rotary equalizer. We gain this much, however: during the hours of light load the batteries may supply all the current required, permitting the shutting down of the central station during those hours.

7. I intend now to bring to your notice an equalizer that has passed the experimental stage and has been in operation day and night for two and one-half years; no lamps have ever been lost owing to lack of balance of the system. Again, we only require one generator, A, 220 volts, and one small machine with two commutators, B, Fig 6. We have only two bearings to worry about. Only one field loss; one loss due to hysteresis and eddy currents; and absolutely no armature reaction. There being no armature reaction, there will be no drop in speed, no sparking at the brushes with a change of load, and the capacity of the equalizer will be the heat limit of the armature winding.

By using the equalizer system, we have one unit, or set of

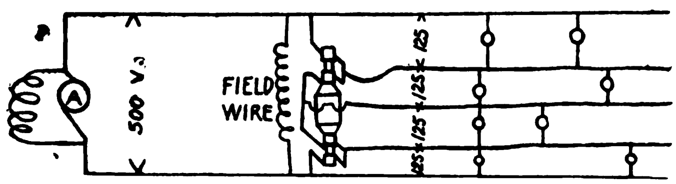

FIG. 7.

units, running at a high efficiency, and for a reserve we have only one machine. It is not limited to only 220 volts. Where a company has a motor trade much scattered, they can take, for instance, 500 volts and run a good distance with economy, then put an equalizer in a central location and supply your customers with lights at 110 to 125 volts, Fig. 7.

Or, again, we want light and power in one unit. We can take one generator, 50 kilowatts, 250 volts, and a motor of 50 horse-power, but with two commutators; or, in other words, on a 50 horse-power equalizer we can take either the full load in power off the pulley or the full number of lights off one side at 110-125 volts, or in any proportion we see fit.

Still another advantage of this system: we can always compensate for the drop in our line at any point independent of all others. This we might call a booster equalizer system. When the heaviest loads are on our system and the sides balanced, all the equalizer does is to run free as a motor. Now,

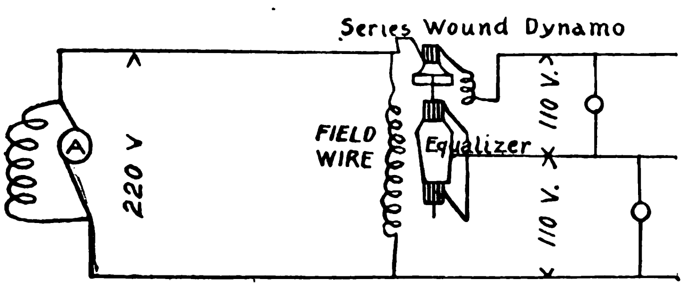

FIG. 8.

by attaching a small series wound dynamo to the end of the shaft of the equalizer, and adjusting it to the load and drop, we will first boost our pressure and then equalize it. So that, given a district with various points of distribution and various drops, we can run even the longest and heaviest loaded circuit at the same pressure as our station e. m. f., Fig. 8.

RESULTS ACCOMPLISHED IN DISTRIBUTION OF LIGHT AND POWER BY ALTERNATING CURRENTS.[1]

BY W. L. R. EMMET.

The introduction of successful polyphase motors has constituted a very radical and important step in the development of the electrical art. The number of persons who realize the importance of this step is as yet small, and, like other new things, it can not attain great successes until its merits and possibilities become more or less familiar to the public and to the practical business men on whom the responsibilities for new developments must largely rest. In the past, the use of alternating currents has been almost exclusively for incandescent lighting, and this narrow limitation has crippled the development of the art. While the applications of direct currents have called forth very large investments in plants and distributing systems, the uses of the alternating current have, as a rule, been on a much smaller scale, and the methods used have been developed rather with a view to reduction in first cost, than to the attainment of the most economical results in operation.

The reasons for this somewhat half-hearted development may be stated as follows: First—The average efficiencies attained in most alternating plants have been very low. Second—The distribution of potential obtainable with the ordinary methods has been imperfect. Third—No reliable alternating arc lamps have been available. Fourth—No practicable form of single-phase alternating current motor has, up to the present time, been introduced.

At no time have all these difficulties been entirely unavoidable in alternating current distribution; they have, however, been fixed features of the system as it has in the past been installed by our manufacturing companies and used by electric light companies in this country; the state of the art being such that improvements were beyond the reach of most central station managers.

In recent years great developments have been in progress in the branches of electrical science pertaining to alternating currents; much new apparatus has been developed, plants have been installed on new lines, and practical results are to-day being accomplished that show that it is possible to overcome all of the objections which have been mentioned.

We will briefly review in order some of the means by which the difficulties mentioned have been and can be avoided.

EFFICIENCY.—The greatest losses in the average alternating plant are due to the waste in iron cores of transformers, which goes on whether the transformers are loaded or not. This waste can be reduced, either by the use of transformers of high light load efficiency, or by arrangements for cutting out transformers at light load.

Where primary distribution is used with large numbers of independent transformers, the extent to which these remedies can be adopted is very limited, since reduction of core loss can be obtained only at the expense either of regulation or of first cost. If, however, secondary distribution is used, that is, low-tension mains with transformer sub-stations, it is often possible to arrange means of cutting out transformers at times of light loads. Furthermore, on such systems very accurate regulation in transformers is a matter of no importance, since all transformers divide the load more or less evenly between them, instead of operating from the same line at various conditions of load as in primary distribution. Thus, for this secondary work, we can built special transformers having very small core losses and thus obtain very high all-day efficiency without impairment of regulation.

I have in mind a large plant now being equipped with alternating apparatus for lighting and power distribution on thoroughly modern and improved lines. In this case a system of three-wire, low-tension mains is to be laid over a large area. These mains will be fed at street corners from specially designed transformers in ventilated manholes. These transformers are to be of 100 kilowatts each, and are to have a core loss of only 500 watts, or one-half of one per cent of the capacity. The efficiency of these transformers at one-quarter load will be higher than at full load, the principal loss being in the copper. Thus a transformer may be made to fill the same functions as a direct current feeder. If we are willing to introduce some drop between generator and main, we can get high light load efficiency with moderate cost, and we shall retain the important advantage that transmission is possible over long distances, with small losses, through the use of high voltage.

REGULATION.—The cause of bad regulation in most existing alternating plants is that each individaul installation is connected to a separate transformer, and that in these transformers, and the wiring connected to them, there are losses varying with

[1] Read before the N. E. L. A., New York, May 5, 6, 7. Abstract.

the load, which, of course, can not be controlled from the station. Since regulation is a matter of most vital importance, we see that with primary distribution good regulation in transformers is imperative. To make transformers of specially good regulation, something must be sacrificed, either in economy of first cost, or in light load efficiency, or in both. Thus there is always an appreciable drop through resistance of wire in transformers, and this, combined with the drop in primary and secondary wiring, gives rise to serious vibrations in pressure on lights at different points.

Another fruitful source of potential variations on alternating circuits is found in the self-induction of circuits and also in the self-induction of transformers. The electromotive forces introduced by self-induction being out of phase with the current, are variable in their effect, and give rise to troubles that sometimes seem erratic, although in reality they are governed by well defined laws, which, if properly observed, enable us to obtain accurate results.

MOTORS.—Until very recently the operation of motors from alternating systems has been practically out of the question, since no suitable motor has been obtainable. Thus alternating apparatus has been available only for lighting, while in direct current stations motor load during the day has been a most important source of profit. It may be mentioned here that while incandescent lighting is at the present time meeting sharp competition from other forms of illumination, the electric motor is growing very rapidly in popularity. It has taken the public a long time to gain confidence in electric power and to realize its usefulness. It is only within very recent years that large manufacturers have begun to use electrical power distribution to any extent. At present, the work is being carried on very actively, and highly successful and economical results are being obtained in many large mills. As a means of power distribution, even for short distances, electricity has no rival; while for lighting, its advantages, though great, are relatively much less positive.

Although for many years efficient electric motors have been in general use, there are many central stations in whose business power distribution has not been a very important factor. There are several causes which have tended to restrict the use of electric power, among which we may mention the following: Voltages that have been available for direct current work have not admitted of transmission to considerable distances. Motors have required a certain amount of attention, which users were sometimes unwilling to bestow. In certain classes of manufacture, the sparking of motors has been a source of danger. The most important cause, however, has been that, as a rule, the same apparatus has not been available for the operation of

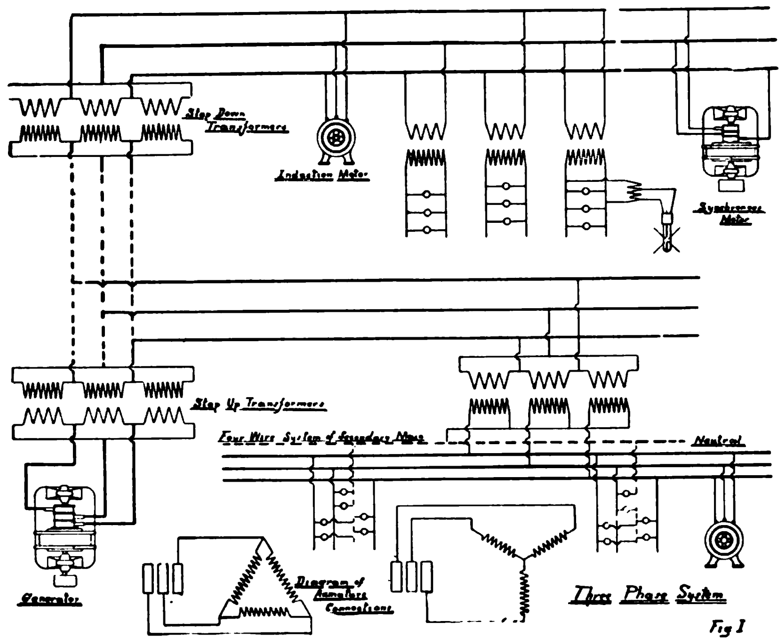

FIG. 1.

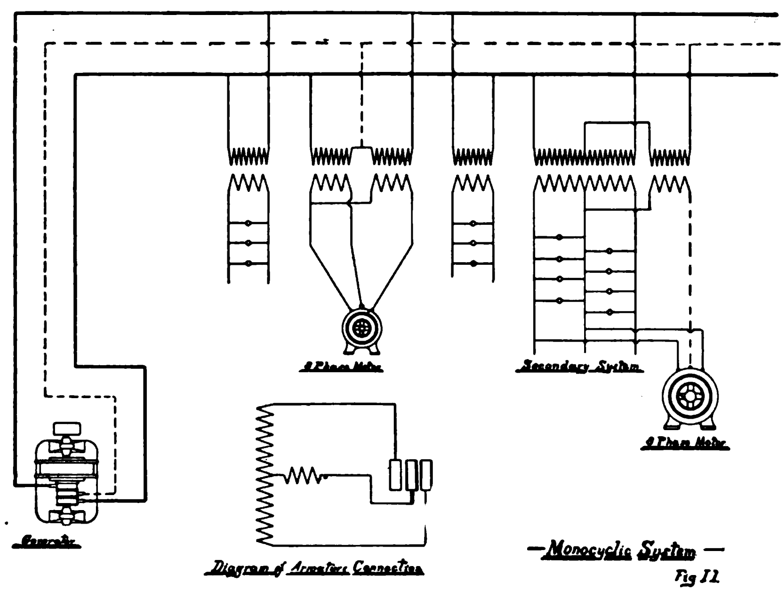

FIG. 2.

lights and motors; consequently, central stations have not been in a position to make attractive offers to large users of power.

With facilities for electric power transmission thus improved, we may look for great developments in the sale of power from central stations. When it is profitable for large manufacturing establishments to put in electric plants for the purpose of distributing power on their own premises, there should certainly be profit in the sale by electric companies of power to large as well as small manufacturers.

The actual saving in fuel effected in the operation of a large mill by electricity for power distribution is ordinarily very large; often as much as fifty per cent. With good equipment, this is, however, only a small part of the saving effected by electrical distribution. The cost of coal seldom amounts to more than half the expense incident to the production of power, and in most cases it is a much smaller proportion of the total. If the power is obtained from a central station, the coal is bought cheaper and used more economically, while the other items of expense will in many cases be almost a clear saving.

The introduction on any large scale of electrical power distribution, of course, requires the investment of a good deal of money in motors and alterations of plant. Power users are often slow to make these investments, because they are not familiar with electrical apparatus and do not realize the advantages to be gained. Repeated investigations have proved that users almost always far underestimate the cost of power. It is the business of the central manager to correct these misconceptions, and to awaken interest in electrical methods. Of course, many companies are working zealously just on these lines. There is no question, however, that there is in many of our large cities a large amount of undeveloped power business. If electrical manufacturers can induce large mill owners to put in plants for electrical power distribution, central stations should be able to sell power to similar concerns.

The following facts concerning sale of alternating power apparatus by one company alone will illustrate the hold which the modern improvements above mentioned have already taken upon the industry of the country:

The first three-phase apparatus made in this country was put in operation two and half years ago. Since then that company has put in operation 33,500 horse-power capacity in three-phase generators; 10,000 horse-power in three-phase induction motors; 14,800 horse-power in monocyclic generators; 6,000 horse-power in three-phase synchronous motors; 10,560 horse-power in rotary converters, and 42,000 horse-power in transformers used for power purposes; the average capacity of the latter being 16 horse-power and the largest having a capacity of 1,100 horse-power.

The production of this apparatus has involved the complete design and development of about thirty new forms of dynamos and thirty-three new forms of motors; each machine so developed involving the construction of new patterns and special tools, which, with drawings, etc., cost in the average about one thousand dollars for each new machine.

The different methods of distributing power and light by alternating currents can best be illustrated by diagrams showing the connections used with each. We briefly review some of the applications of the systems now in general use.

Fig. 1 shows the three-phase system as ordinarily applied to the transmission of power for lighting and other purposes over long distances. The generator may be of any convenient voltage, since step-up transformers are used. These transformers are in three units, or groups, any two of these units being available to transmit a large proportion of the power in case one is disabled. Two sets of step-down transformers are shown, one supplying 1,000-volt distributing lines, and the other supplying a system of four-wire secondary mains. With a given lamp voltage, such mains give a slightly better copper economy than the ordinary three-wire system, and afford an excellent means of secondary distribution.

Such a system as is illustrated in this figure, will give excellent service almost in any town, the low-tension mains taking care of the thickly built up portion and carrying the bulk of the lighting load, while the high tension distributing system covers all outlying portions and operates large power units. A number of large plants have been installed within the last two years, using the three-phase system, as here shown.

Fig. 2 shows the connections for distribution by the monocyclic system. Here all lights are connected single-phase between a single pair of conductors leading from the generator, the motors being operated from the same single-phase circuit in combination with a third conductor leading from what is known as the "teazer coil" on the generator. Here the simple three-wire system is used for secondary distribution, and if it is desired to connect motors to the low-tension mains, a supplementary transformer is used, which supplies a secondary teazer wire; to this and the outside wires of the three-wire system the motors are connected.

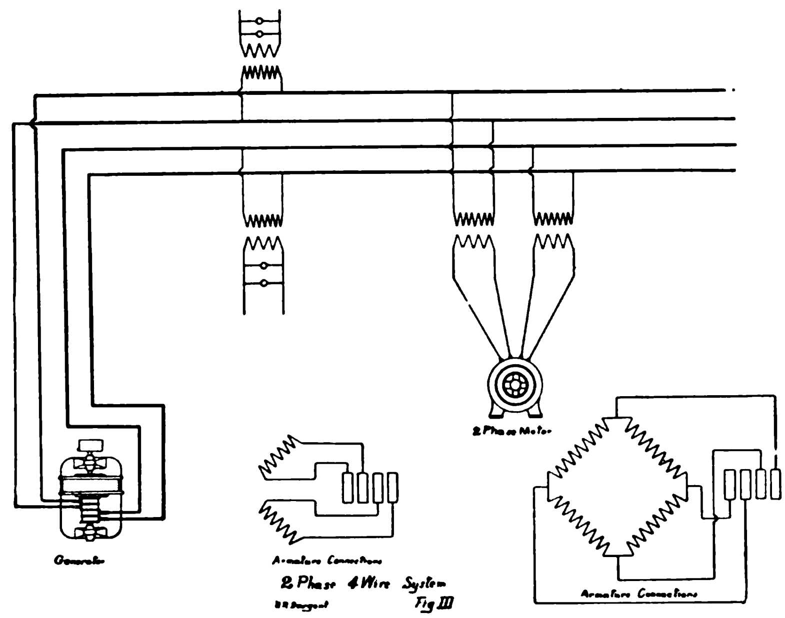

FIG. 3.

The great merits of the monocyclic system are that the number of conductors required for lighting and power distribution is reduced to a minimum, and that no unbalancing is possible. The operation of three-phase motors from this system is in all practical respects the same as when they are run from three-phase circuits.

Fig. 3 shows the connections of the two-phase system, with distribution by four conductors. Here the lighting is divided between two separate circuits, which must be kept balanced within certain limits, depending upon the regulation of the generator, or the amount of care that can be given to the adjustment of pressure on the different sides. Where motors are run, the two circuits must be brought together.

There is no economical and convenient way of operating secondary distribution from this system. Two independent three-wire systems could be operated, but these must be brought together when motors are run. The complication of balancing such a system would be prohibitory.

The two-phase, four-wire system can be operated either from a generator with two independent circuits, or all four conductors can lead from one armature winding. Certain advantages may be claimed for both methods, and both have disadvantages.

Fig. 4 shows a method of single-phase lighting distribution from a two-phase dynamo. Here the two single-phase leads are taken out at points 180 deg. apart on a progressive armature winding. At points ninety deg from those leads two other leads are brought out; each of the latter can be used with the pair of single-phase leads to run one-half the capacity of the machine in two-phase motors. These two power loads can not, however, be brought together.

The greatest disadvantage of this system is that, when carrying a single-phase load, a large proportion of the armature conductors are ineffective, and simply introduce useless resistance and self-induction in the circuit. Thus with the same loss the generator will deliver forty-two per cent. more power as a quarter-phase machine than it will as a single-phase machine.

Fig. 5 illustrates the two-phase, three-wire system, which has been used to some extent both for high tension distribution and for distribution by secondary mains. The principal advantage in this system is that it requires one less conductor than the four-wire, two-phase system. Its disadvantages are that the insulation of the apparatus is subjected to a voltage forty-two per cent. higher than that which is available in transmission, and that the self-induction in the lines and transformers causes an unbalancing of the voltages on the two sides of the system, accompanied by the distortion of the phase variation. The extent of this unbalancing depends upon existing conditions, and is very different in different cases.

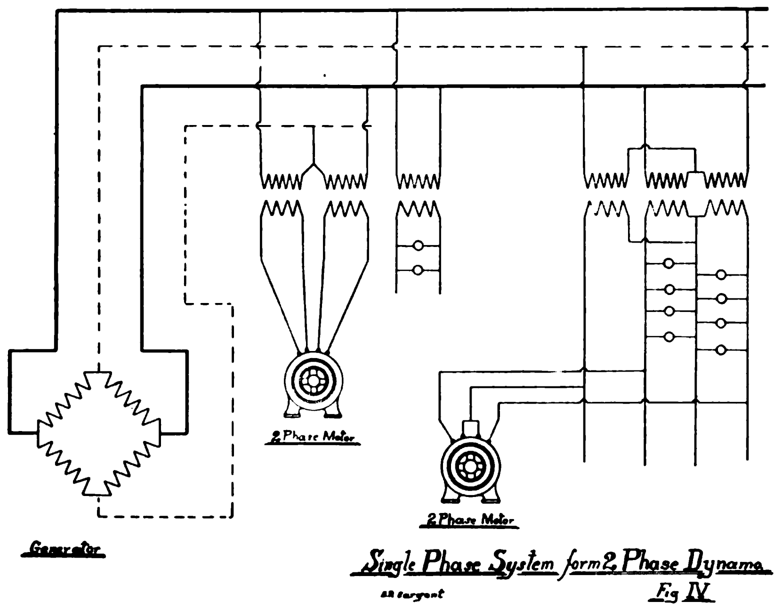

FIG. 4.

In addition to the systems above described for distributing power by induction motors, we have other means of power distribution by alternating currents. The synchronous motor, for certain classes of work, is highly efficient and reliable, and is extensively used, although it will not fill all the requirements of general power distribution. The rotary converter also fills a very important place in the engineering work of the day. A synchronous motor is simply an alternating dynamo whose functions are reversed. They may be used either on single-phase or polyphase circuits. In its simple form, a synchronous motor has no power of starting itself on a single-phase circuit. On a polyphase circuit it starts with more or less torque as an induction motor, and will come to synchronism. As a rule, however, the starting of synchronous motors is not vigorous, and is accomplished by a large draught of current; hence their applications are limited.

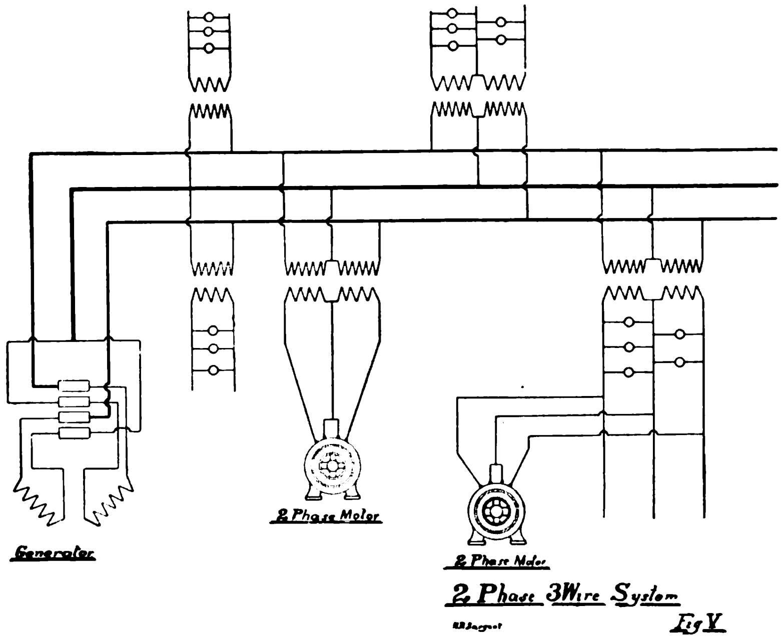

FIG. 5.

A rotary converter is a synchronous motor of suitable construction, whose armature windings, besides being connected to collector rings, are also connected to a commutator. As the machine revolves at synchronous speed, brushes collect direct

current from the commutator, this current being partly rectified and partly generated by the machine. This machine deals in direct and alternating currents and mechanical power; supply it with any one of the three, it will deliver either one or both of the others. It is most efficient when filling its functions as a converter from alternating to direct currents. Its capacity is then greater and its efficiency higher than when it runs as a generator or as a motor.

To illustrate the use of the rotary converter, I will describe an application now under consideration. The company in question is operating three stations; one of these is very large and centrally situated, with condensing water and every facility for the cheap generation of current. Each of the other stations is about two miles from the main stations; both work non-condensing. One of these stations delivers current only on the direct current, three-wire system, while the other, in addition to similar work, carries a considerable arc light load. In this case the following plan is considered:

At the two smaller stations rotary converters would be installed, and would deliver only direct current in one case, while in the other they would also act as motors to operate arc machines through a countershaft, to which they would be belted with clutch pulleys. Suitable step-down transformers would connect the rotary converters to a high tension line leading to the main station. At the same station three-phase generators of large capacity would be installed. These generators would be designed to deliver both three-phase alternating currents to step-up transformers, and also direct currents at about 250 volts to the outside conductors of the three-wire system. They would be directly coupled to engines. These machines would deliver current simultaneously, in any proportion, to the direct current, three-wire system, to the rotary converter, or to lines distributing three-phase power.

It is proposed to operate these machines at a frequency of twenty-five cycles per second, this being well adapted to the direct current work and also to three-phase power distribution.

In this plant an entirely independent control of direct current pressure within a wide range would be necessary at the main and sub-stations. This would be effected without the introduction of idle currents, by the use of a novel form of three-phase induction regulator connected to the alternating leads of each rotary converter. These regulators would give a wide range of adjustment without any moving connections. and would greatly simplify the operation of the plant, and also increase its economy, since the losses introduced by the regulators themselves are very small, and since conditions of general economy are always maintained. Thus a single engine could carry the whole load of the city at certain times.

Another interesting illustration of a combination of alternating and direct currents is found in a case now under consideration. A company controls about 3,000 horse power in water at a distance of eleven miles from a large town. It is proposed to install three-phase, sixty-cycle generators in 600 kilowatt units. The current from these generators will be transformed to 10,000 volts and carried over three wires to a city sub-station centrally placed. Here large step-down transformers will be installed, delivering current to 2,000 volt lines, which extend all over the city and carry motors and lights in outlying parts.

In the same station two large Corliss engines are now in operation, and are belted to clutch pulleys on a countershaft, which operates some arc machines and other load. To this same countershaft it is proposed to couple with a clutch a large synchronous motor which will be connected to the 2,000 volt lines. When the water supply is ample, the engines will be shut down and the motor will run the shaft. When the water is low, or more power is required, the engines will be run and the synchronous motor will then act as a generator, running in parallel with the transmission line.

In the central part of the town it is proposed to install a system of three-wire mains and a large storage battery. This battery would be installed in a second sub-station, conveniently placed. It would be charged from a pair of direct current machines, directly coupled to a synchronous motor operating from the 2,000 volt lines. The direct current machines would be used in connection with the batteries for supplying the three-wire system. The plan here outlined has many positive advantages.

The pressure on the 2,000 volt system can, within certain limits, be controlled at the sub-station by adjustments of the field of the synchronous motor. With telephone communication to the power house, the control will be perfectly easy. The peak of the lighting load being borne by the battery, the generators can be loaded nearly to their full capacity with motors during the day. At night they will charge batteries, using water which would otherwise run to waste.

In both the plants described, the cost of labor would be very small, one man being enough to operate each of the sub-stations mentioned. The saving of labor in operation should be kept constantly in view in all engineering plans. Some of the greatest advantages in modern apparatus lie in its adaptability to such saving.

EVOLUTION OF INTERIOR CONDUITS FROM THE ELECTRICAL STANDPOINT.[1]—I.

BY LUTHER STIERINGER, M. I. E. E.

THE fact that a conference, organized under the auspices of this Association, to secure better electrical construction, was held recently in this city, is in itself an evidence of the importance attaching to the general subject. But the national and influential character of the bodies represented is further proof of the anxiety felt in regard to the matter, and the desire for a higher grade of work. In particular does that feeling concern interior wiring for buildings of all kinds. There is a feeling that the future and prosperity of electricity depend on the methods by which current is introduced into and distributed through modern offices, modern houses, and modern halls. It is felt that, in many respects, electricity has reversed the methods of road-making. In almost every city the roads are fairly good; in most they are excellent. When you strike the country you are likely to find boggy, rocky, uneven tracks and paths, which cause disaster to the buggy and the bicycle. In electrical practice, we have got our main roads in pretty good shape; but when we come to the city line, or, in other words, to the confines of the building, there we begin to strike the wildest and strangest vagaries in the plan and construction of paths for the current that can possibly be conceived. Where the electrical road building, or, as the French say, "canalisation," should be best, it is worst. Let us examine the problem thus disclosed, with the object of finding a plan of improvement. Let us see where the art of interior wiring started, the point it has attained, and the end at which it should be aimed.

Webster defines a conduit as a pipe, canal, channel, or a passage for conveying water or fluid.

According to the standard rules (National Board of Fire Underwriters, 1896), the object of a tube or conduit is to facilitate the insertion or extraction of the conductors, to protect them from mechanical injury, and, as far as possible, from moisture. Tubes or conduits are to be considered merely as raceways, and are not to be relied on for insulation between wire and wire, or between the wire and the ground.

In the development of interior electrical distribution, it is necessary to briefly review the history of the use of the conduit for water, gas, and steam, especially, before the introduction of the powerful electric currents necessary to supply light and power.

GAS FITTING.—In the early gas installations in England, lead pipe was used quite extensively. The work was performed at that time by the plumber. The term "gas fitter" originated and became a special trade in the United States when iron fittings were introduced. Prior to that stage in the art, fittings were improvised by brazing a saddle of brass on a piece of iron pipe. This saddle had a protuberance threaded with a male thread, and after being brazed to the pipe was drilled for a gas way, thus forming an outlet to which a coupling could be attached. The present form of gas fitter's tee is an equivalent of what has just been described. Lead was never employed in the United States for gas piping, except for meter connections and temporary work.

In one of the earliest gas systems in Philadelphia, in 1835, iron mains were run on the outside of the houses, with stop-cocks arranged so that the gas might be turned off before the family retired for the night. This was thought necessary for security, on the supposition that otherwise some unknown cause might develop leaks or trouble. In France, at one period, all gas piping in interiors was left exposed for more ready inspection. The crude methods of installation in that day did not inspire confidence in concealed pipes. Service stop-cocks are still placed near the street curb, as a provision principally against fire, in case the meter or other connections in the interior of the buildings be melted or dislocated and the escaping gas continues to do damage.

On the Continent of Europe there is generally a main tap on the exteriors of premises attached to the service pipe, for the purpose of shutting off the gas when desirable. At the time of the famous Barnum Museum fire on Broadway and Prince street, New York, the inability of the firemen to get at such service cocks, owing to ice-covered débris, permitted the escape of gas inside of the building line to such an extent that the volume of flame rivaled a burning gas well. This continued for several days before it could be controlled.

[1]Read before the N. E. L. A., New York, May 5, 6 and 7, 1896.

Escaping gas is more dangerous than any other medium distributed in a building. Many years of experience have proved that the use of iron piping to convey gas has minimized all possible dangers from leaks or other causes. The early fitting art, by its use of split dies and poor material, was responsible for any lack of confidence as to the ability to confine water or gas to the conduits or pipes.

The reliability of gas, water, and steam conduits in interiors, and the general public confidence in them to-day, can be traced to the creation of the solid die for cutting threads to proper fittings, to superior pipes and to standard threads.

In the United States, prior to 1860, neither water nor gas distributions in buildings, especially in residences, were very extensive. The vitiating effects of gas on the atmosphere of a closed room prevented its use in Europe until a comparatively recent date, except in corridors, assembly rooms, factories and public places. Sleeping apartments are still rarely supplied in England. In this country, however, at the period mentioned, gas was much more extensively used both in residences and elsewhere.

At one period, when cast iron street mains were very expensive, and costly as compared to present prices, several attempts were made to substitute pipes of other material. In a city in the western part of England, an extensive trial was made of transmitting gas through brick conduits and earthenware pipes like the drain pipes of the present day. Pipes of earthenware were used on an extensive scale in some towns in France, the joints of which were made of Roman cement, and the services attached by punching a hole in the main and inserting the end of the leaden service pipe which was secured with cement. This method resulted in complete failure, and several gas companies were all but ruined by resorting to it. The excessive cost of cast iron retarded gas as well as water distribution, enforcing even the use of wood coated with asphaltum as conduits for street mains. During the infancy of street gas distribution, cast iron pipes were made with flanges and put together with bolts and cardboard washers. This practice had to be abandoned and lead joints were at length universally employed. The same method was adopted in water mains. The first street mains for gas, laid in 1807, in Pall Mall street, in London, were of lead. Tinned iron and copper were also used. Paper pipes were in use early in this century for water and gas mains. When used for the latter purpose, they were lined with lead to prevent the hydro-carbon in the bituminized paper from being acted on. Tile pipe as large as twelve inches in diameter was also used.

PLUMBING.—Early plumbing did not comprehend any installation beyond water required for culinary or other special purposes; the introduction of the bath and more lavish use of water only following the more plentiful supply from comprehensive "Central Station" water systems.

It is not many years ago that water had to be drawn from wells and other sources, and carried to receptacles for short storage. Where the luxury of a bath was introduced years ago, it was installed in an outhouse, or an extension to a dwelling or a building, to simplify and reduce the cost of installation. This generally required an extension of the pipes to serve points distant from the street service. For this purpose lead pipe only was used, which caused much annoyance and trouble. The settling of the soft, pliable pipe, if not thoroughly supported, prevented a thorough drainage; and in cold weather the pipes were constantly freezing and bursting. This was the origin of the plumber-millionaire joke.

The use of saws, chisels, and nails, by mechanics in the performance of their work, proved to be a constant source of injury to the pipes, and, as these injuries frequently occurred when the water was turned on, great damage was done to frescoings and furnishings before the source of leakage could be discovered and corrected. Rats and mice would also frequently gnaw into such conduits and cause the escape of the water.

One of the first deviations from the lead pipe practice on an extensive scale was in the latest Western Union Telegraph Building, in New York, on Broadway, in 1870. To avoid the difficulties before mentioned, this building was piped with tinlined brass pipes. From that time on, the practice became general of using in all concealed spaces galvanized iron or brass pipe that could be relied on as safeguard against any of the aforesaid difficulties so that damage might be avoided.

STEAM HEATING.—This is another form of distribution now in general use. It is effected with perfect safety when installed according to modern practices, with metal pipe of sufficient strength to withstand the pressure from within and injury from without.

In the three systems of distribution, which have been outlined as briefly as possible, viz., Gas, Water, and Steam, the following should be noted:

Water produces damage only when allowed to escape, and then only by flooding interiors. Steam is so well harnessed that its escape in a measure does not differ materially in the results developed by water, except that it may cause personal injury through scalding. Gas, however, unharnessed and not properly confined, is capable of twofold destruction: 1st. Its ignition may set fire to surroundings. 2d. Its explosiveness, when pocketed and under suitable conditions. It is also extremely poisonous when escaping and unlit.

It is very rare that dislocation or deterioration in gas piping results harmfully in properly installed systems of gas piping in interiors. The fixtures, of course, are more or less handled, and are liable to derangement, but as they are thoroughly accessible and in full sight, any leaks are easily discovered and corrected.

ELECTRICAL DISTRIBUTION.—In 1881, upon the introduction of the incandescent light, which was designed to supplant gas systems, the promoter's contention, outrunning the inventor's more modest claims, was that the new electrical illumination required the simplest kind of wiring at small cost. The purchaser's objections to duplicating a system of distribution in a building already containing gas piping, induced the promoter to make further statements in the direction of cheapness, which culminated in the claim that the gas pipes already in place could be utilized, and that the electrical conductors could be inserted within them. This was inexplicable to the purchaser, who was told—what at that time became a standing joke—that Mr. Edison had devised an electric bug, and all that was necessary was to attach a wire, insert the bug in the pipe and turn the current on, and it would crawl along and carry the wire with it to any required destination, thus enabling the wire to be placed without difficulty and at little cost. As a matter of fact, Mr. Edison was trying to get the "bugs" out of the system.

With the first installation this question of conductors and their location became one of very serious moment. The method employed was that of a distribution based on a circulation similar to the arteries of the human body, diminishing in size from the source of supply to the points of requirement. Fuses were only applied at the generator, or source of supply, and at the lamp holders, and were designed for this special protection only. Very few intermediates and cut-outs were used, and these were placed in the most inaccessible and unusual positions, and only on one side of the circuits.

Paraffin-covered wire, as employed in prior telegraph and annunciator installations, was adopted for electric light work. This often became heated to such an extent that it frequently set fire to the insulation, and produced burning wires for long stretches between floors and ceilings and under floors. When this came to the notice of the underwriters, they insisted on a non-inflammable wire, commonly known as the "Underwriters" wire, which had a coating of zinc on a cotton fiber braid. This covering, while not being combustible, permitted infiltration of moisture, which caused electroyltic action and the consequent rapid destruction of the wire. Some of the wire gave such bad results in moist places that a twin wire with bituminous covering was substituted. It was known as "Paragon" wire. Much of this for a time gave very good results. The material, however, deteriorated, principally on account of air checks and cracking insulation, and its use had to be discontinued.

About this time various grades of composite and rubber-covered wires of high insulation were introduced with satisfactory results. As in much of the early work done, the wire was supported on cleats and treated practically as if it were bare wire, and as concealed wiring was generally placed in dry structures, defects did not manifest themselves as rapidly as they would otherwise have done.

In the early history of electric lighting, an interior conduit system of wiring was employed. The importance of concealing the conductors in the fixtures necessitated considerable simplicity in wiring to make the same practicable. This was accomplished in the very first commercial fixture, and the general plan then evolved is now in universal use the world over, having completely displaced all attempts to introduce special electric structures.

The attempt of the electrician of that period was to create these special structures just alluded to, based on the lines of his prior practices in telegraphy and other feeble current-carrying arts, introducing contacts, binding posts and other paraphernalia, believing that in this way the whole fixture art would be overturned to make way for the new illuminant. Fixtures, however, are the same to-day as they were before the electric lighting art, except in the modifications of the internal portions so as to admit of inserting or withdrawing the conductors and in the angle at which the light can be directed or suspended.

Internally wired fixtures have been and are placed in all kinds of positions. Where the interior of the tubes has been

exposed to moisture, the inlets have been closed, thereby preventing air circulation and consequent precipitation of moisture. No appreciable deterioration resulted, even where poorer grades of wire were used.

Gas pipe or brass tubing, without any insulation, has been the form of conduit in which conductors were placed in fixtures, the only additional provision in a plain iron pipe that was used being in the case of combination fixtures, where the outside of the iron pipe was taped to prevent chafing of the wires. This was abandoned as soon as the manufacturers recognized the necessity of using properly insulated wire and of so constructing the metal covering of the iron pipe as to prevent chafing. In a paper read before the World's Fair Insurance Congress at the World's Columbian Exposition in 1893, the value of iron conduits was fully recognized, an extract from which is given in the Appendix.

So far as interior electric conduits are concerned, it may be said that they were in use with the first installation, and have been continued, representing the most advanced form of the art, in the large number of fixtures that have been installed. Many of the early plants, such as in mill work, and some of the early expositions have almost as many feet of conductors in the long pipes pendent from the ceilings as there is wiring in the branch circuits.

When it became necessary to conceal wiring, it was common practice to insert moldings (a legacy of the telegraph installations) in floor beams and put the conductors into the grooves provided. There were also many instances at that time of the separation of gas pipe lines and of their utilization for the purpose of inserting conductors, rather than mar the walls or surroundings by external placement. In the fire-room of the steamer "Pilgrim" in 1883, several hundred feet of brass tube were placed without any insulation other than on the conductors. Several other steamships about that time had galvanized iron pipe as conduits without any insulation. It gave good service.

The use of speaking tubes to serve as conduits was quite frequent in early electric light work. A notable installation of this sort was in a large residence at Greenwich, Conn., in 1887. Although the best electrical talent was employed, the mechanical work did not permit of inserting or withdrawing the conductors freely, and they became more or less fixed in position, with the result that the installation had to be overhauled. In fitting up a cottage on the same premises with electric light, small brass-pipe tubing was used. The runs were not long, and the bends, or sweeps, were, therefore, easily placed, and could be concealed without difficulty. Ordinary flexible cords were inserted as conductors, giving satisfactory results. This tube not having been closed at its terminals, permitted circulation of air and developed moisture, which, however, did no harm.

About this time a twin conductor was evolved, based on comparatively no insulation. This twin conductor was patented. The copper conductors were separately covered with a thin cotton covering, without any high insulation. These were laid side by side, and both were covered with additional insulation. The object in closely associating these two conductors in this way was to assure the blowing of a fuse in case of a leak or short circuit. The proximity of the conductors would produce a low resistance arc, the rush of current at that point resulting in the rupture of the fuse. This method was subsequently put into commercial practice, but had to be abandoned, as it developed more faults than the evil it sought to correct, and largely assisted in establishing the use of highly insulated conductors in conduits and raceways in interior installations.

Shortly after the Greenwich installation, a paper tube, impregnated with bituminous compound, was produced. A considerable quantity of this tube was marketed before it was found that, if concealed in plaster or cement, it failed to resist chemical action that ultimately destroyed it. To overcome this, the paper tube was covered with a thin brass sheathing or covering. This, while to some extent resisting chemical action arising from proximity to plaster or cement, was, nevertheless, susceptible to mechanical injury.

During the time that this brass tube was being developed and marketed, the value of an interior conduit system as a means of readily inserting and withdrawing a conductor, was fully recognized by engineers and constructors. A paper was read before the meeting of the National Electric Light Association at Detroit, in September, 1886, entitled "Some Features of Incandescent Lighting and Wiring." In this paper the advantages of a system of distribution and control versus circulation, were fully recognized. Distribution of current in buildings became more systematized through the adoption of a system of distribution and control. (See Appendix.)

The distribution and control system was first brought into comprehensive use in the St. Louis Exposition Building, in 1885, in a permanent plant of over 5,000 lights, in which all the circuits were derived from points of distribution, there being some twenty or more distributing points arranged in the building, with over 400 or 500 local circuits. Had the system thus introduced at that exposition been in general use, as it is now in the best practice conduits would long ago have been extended in the iron, steel or other metal form, from the fixture back to the source of supply, thus filling the gap between the two points, and preventing any disturbance or injury to conductors placed within them.

In the construction of buildings, various artisans must in turn complete their work. The gas piper, the plumber and steam fitter, each has his operations so arranged that he can practically complete the work before the plastering, woodwork and general finish have even been commenced. The use of the conduit likewise permits in branch lines, such as are confined to rooms, the placing of the electrical material in advance of the plasterer or trimmer, if such conduiting be properly arranged between distributing points to which the mains are brought.

At the World's Fair, in 1892, the question came up as to the protection of the conductors, some of which were carrying 2,000 volts alternating current within the buildings. As these conductors in many cases had to be placed under the floors, it became a very important matter to secure them against injury. In considering various methods of protection, all forms of manufactured insulated tubes then on the market, including various kinds of moldings, were rejected, as not affording that freedom from the damage that nails, chisels and other casual or malicious interference might cause. As a result, the Chief of Construction authorized the use of plain iron pipe, relying entirely on the sufficiency of the insulation of the conductors therein placed. The large amount of bare iron pipe so used gave absolutely satisfactory service. The results of this experiment proved conclusively to the various engineers and constructors attached to the electrical work of the Columbian World's Fair the value and sufficiency of the protection afforded by bare iron pipe, since which time they have one and all been firm advocates of its use for conduit purposes.

In 1889, at the retail store of A. T. Stewart, Broadway and Tenth street, New York City, there were installed over 3,000 lamps. All the primary feeders connecting the various converters were placed in gas pipes. The pipes were laid on the iron ledges of the building. Although these pipes and wires of a total length of about two miles were placed by inexperienced men, they were in constant and successful use for over five years, conveying satisfactorily a current of 15 amperes and 1,000 volts, or 200 horse-power, although constantly exposed to the weather. In the subsequent installation of an isolated plant, the above mentioned conductors were again used. In New York and elsewhere, thousands and thousands of feet of plain iron pipe have been in use for many years with high pressure currents operated in them; and there is probably more non-insulated iron pipe in use to-day, much of which was installed many years ago, than in all other forms of insulated conduits so far placed.

To further illustrate the foregoing facts, it may be said that there are about 30,000,000 incandescent lamps in use to-day. Assuming that there are but six inches of pipe to each lamp fixture, we have a total of 15,000,000 feet, or several thousand miles of non-insulated iron or brass pipe in use in fixtures alone; no insulation of the same, other than that furnished with the conductors, having been found necessary.

The best experience of the past 15 years in interior wiring has demonstrated the following facts: 1st. Indiscriminate wiring with staples is universally condemned. 2d. Cleat wiring is admissible in exposed work where the circumstances admit, but not in any concealed work. 3d. Wires imbedded in plaster, depending on the insulation only for protection, are condemned. 4th. Lead-covered wires are also condemned, except where protected in a conduit. 5th. Wires in moldings do not afford mechanical or chemical protection, and are only admissible in surface work. 6th. Wires carried in plaster and covered with split or zinc tubes to prevent injury by trowels, are condemned. 7th. Glass or porcelain insulators can only be utilized in special cases of exposed work. 8th. Paper tubes do not afford absolute mechanical and chemical protection. 9th. Insulated tubes covered with a thin coating of brass or other metals, do not afford absolute mechanical and chemical protection, but, in exposed work, they are, to a certain extent, admissible. 10th. Woven fabric conduit does not afford absolute chemical and mechanical protection. 11th. Heavy insulating covering, integral with the insulation, offers no absolute protection against mechanical and chemical injury, and is analogous to rubber tubing for gas distribution installed throughout a building. 12th. Concentric wiring is practiced in England with satisfactory results, but is not in use in the United States. It offers many possibilities in the direction of

a solid and fixed system. 13th. Paper-lined iron or steel pipes, known as "Iron-Armored Conduit," "Builders' Tube," "Armorite," "Clifton," and plain iron or steel pipe, are the only conduits that can afford absolute security against mechanical and chemical injury and assure permanence.

THE COMMERCIAL VALUE OF ACETYLENE GAS AS AN ILLUMINANT.[1]

BY LOUIS A. FERGUSON.

IT is my intention in presenting this paper to treat of acetylene in its commercial aspect as related to the illuminating industry, and to attempt no description of its value in the chemical world, as the latter is a field entirely apart from that invaded by this Association and one so comprehensive that it might well be made the subject of another discourse.

The first step in the process of manufacture of acetylene gas is the production of calcium carbide, which is accomplished by the reduction of lime by carbon with the intense heat of the arc in an electric furnace. The chemical equation representing the action is $CaO + 3C = CaC_2 + CO$, the CaO representing the lime, 3C the carbon, CaC_2 being the symbol of calcium carbide, and CO carbonic monoxide. Although several experimenters produced carbide of calcium and carbide of sodium and from these acetylene gas many years ago, the first production of carbide of calcium on anything like a commercial scale was made by Mr. T. L. Willson at Spray, North Carolina, while endeavoring to produce the metal calcium in the electric furnace. It was my good fortune to have visited with Mr. Willson his plant at Spray and there carried on experiments in the manufacture of the carbide of calcium and the production therefrom of acetylene gas.

The carbon used in the process at Spray is Pocahontas coke, having a 9 per cent. ash. The coke is conveyed to a hurricane mill, where it is ground to a fine powder and then put with the lime into a revolving mixer by which it is thoroughly mixed and prepared for the electric furnace. Theoretically the proportions of lime and carbon necessary for the production of 100 pounds of calcium carbide are 87½ pounds of lime and 56¼ pounds of carbon. These combine according to the formula before mentioned$CaO + 3C = CoO_2 + CO$, 37½ pounds of carbon combining directly with the metal calcium forming calcium carbide, and 18¾ pounds combine with the oxygen of the lime, forming carbon monoxide gas which passes off from the furnace.

Nearly twelve months ago, on May 15, 1895, at Spray, N. C., the writer, together with Mr. George O. Knapp, of Chicago, Mr. T. L. Willson, and Major Morehead, of Spray, N. C., carried on a test to show the actual production of calcium carbide per horse-power per day and the volume of acetylene obtainable per pound of carbide. The coke and lime were prepared in the manner described, the mixture containing 800 pounds of air slaked lime and 390 pounds of powdered coke, making the total weight of mixture 1,190 pounds. Of this mixture 180 pounds were unused, leaving 1,010 pounds, which were delivered to the furnace. The test run was for a period of three hours, during which the mixture was fed into the furnace by shovel, as required, and the material stocked regularly. The current used varied from 900 amperes to 1,200 amperes as extreme limits, but being kept very regularly at about 1,000 amperes, the voltage varying from 90 to 104 at the extreme and being kept fairly constant at 100 volts. Readings were taken approximately every ten minutes during the test and from twenty-three readings the average showed 1,000 amperes and 100 volts, or an average consumption of energy at the terminals of the furnace of 100 kilowatts during the entire run of three hours.

After the current is turned on and the arc made, the carbide begins to form on the bottom of the furnace under the upper carbons in the shape of a block, and as it forms it is necessary to raise the upper carbons to maintain the proper arc, the current passing from the carbons in the form of the arc to the carbide below, the latter now constituting the other pole of the arc and conducting the current to the plate in the bottom of the furnace. The production of the calcium carbide is by the heat of the electric arc alone and not by electrolysis, the temperature of the arc being in the neighborhood of 3,500 deg. to 4,000 deg. C., while that of the ordinary smelting furnaces ranges from 1,200 deg. to 1,500 deg.

At the end of the run the current was cut off, the furnace was allowed to cool down and the product and unused material removed and carefully weighed. During the production of the carbide some of the mixture is lost by passing up the chimney with the gases of reduction, which burn with wild sheets of flame, increasing with their hissing the already deafening roar of the immense alternating current arc. The weight of the calcium carbide actually produced in this test was 139 pounds, the unused material amounting to 607 pounds, to which must be added the water contained in the lime, 165 pounds, making the total unused material 772 pounds. The weight of the mixture delivered to the furnace was, as stated before, 1,010 pounds, so that the actual weight of mixture consumed and lost in the process of manufacture of 139 pounds of calcium carbide was 238 pounds. The efficiency of production therefore would be the weight of carbide produced divided by the weight of mixture used up, or 139 divided by 238, which gives 58.4 per cent. as the efficiency of production.

The next step is to calculate from the results of the tests the amount of carbide produced per kilowatt hour. We have seen that the average value of the energy expended in the production of the carbide was 100 kilowatts and that we produced 139 pounds of carbide in three hours, or at the rate of 46⅓ pounds divided by 100, which is $^{46}/_{100}$ pound, or at the rate of 11.12 pounds of carbide per kilowatt per 24 hour day, or 8.3 pounds per horse-power per day of 24 hours. A sample of this carbide produced, weighing 34.1 grammes, was then taken and the acetylene gas formed by adding water, and the gas evolved, measured by means of special apparatus, showed a result of 5.24 cubic feet of acetylene gas per pound of carbide after making the proper temperature and barometric corrections.

Having thus seen the quantity of calcium carbide produced for each kilowatt hour of energy consumed, and the value of the carbide as a producer of acetylene, we will now take up the method of production of acetylene from the carbide and consider some of its properties before determining the cost of production of the carbide.

Acetylene is produced from the calcium carbide merely by the application of water, the action being shown by the equation: $CaC_2 + 2H_2O = CaOH_2 + C_2H_2$. When the carbide is thus brought in contact with the water the acetylene gas is given off rapidly and its presence is distinguished by its very pungent odor somewhat resembling phosphorus. When lighted, it burns with a deep yellow flame and is extremely sooty, but when generated at an even pressure, and burned with proper burners designed for the use of acetylene, it gives a beautiful white light. The acetylene flame so used is exceedingly tenacious and it is almost impossible to blow it out, which may be considered as an advantage in hotels and other places where rural gentlemen occasionally take up their abode.

A simple method of generating acetylene from the carbide is to use the apparatus described in brief, as follows: Take an ordinary chlorine generator and place within some lumps of the carbide, arrange a glass funnel so that water may be admitted to the interior of the generator, connect the generator by means of a rubber tube to a gasometer, the outer tank being partially filled with water; from the gasometer above the water line another tube connects to a gas pipe with a set of burners attached. Water is then poured gradually in small quantities through the funnel into the generator and upon the carbide. The acetylene gas thus generated passes through the tube to the inside of the gasometer and lifts the gasholder, the position of the latter changing with the quantity of gas generated. The gas is then delivered from the holder by means of the rubber tube to the piping and burners. As the gas is consumed the holder lowers and a fresh supply is generated by admitting more water through the funnel upon the carbide in the generator.

Another method, which is automatic in its action, is to partially submerge a vessel in water, the vessel being open at the bottom and containing the carbide suspended on a screen in the upper part of the vessel. The gas is then drawn from above the carbide, and as long as it is being used, the water remains more or less in contact with the carbide; but as soon as the consumption of gas ceases or diminishes, the pressure of the gas forces the water downward into the lower part of the vessel and away from the carbide, thus causing the generation of the gas to cease. An arrangement similar to this is one proposed for country residences.

Acetylene gas may also be used in its liquid form and is prepared by decomposing the calcium carbide with water in a closed vessel and conducting the generated gas under pressure to a condenser where it liquefies and is then drawn off in tanks for shipment and distribution.

Compared with other gases acetylene has a very high candle-power. Water gas, which is used in nearly all the large cities of the United States for illuminating gas, when burned at the rate of five cubic feet per hour gives from 20 to 25 candle-power, while acetylene when burned at the rate of five cubic feet per hour gives, according to most observers, 240 candle-power, or approximately ten times the illumination of water gas.

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[1]Read before the N. E. L. A., New York, May 5, 6 and 7, 1896. Abstract.

The temperature of the acetylene flame is low as compared with that of water and coal gas, Prof. Lewes placing the temperature of the acetylene flame at 1,000 deg. C. and the coal gas flame at 1,360 deg. C. It has been stated by Prof. Crafts, of the Massachusetts Institute of Technology, that the true relation of the temperature of the present commercial illuminants when giving the same candle-power is: Incandescent light, 1; acetylene, 3; and the water gas, 9; showing that the incandescent lamp gives off the least amount of heat per candle-power, while acetylene gives three times that of the incandescent lamp and one-third that of water gas.

Many experiments have been made by noted scientists and investigators to determine the poisonous qualities of acetylene gas. Guinea-pigs, dogs and other small animals have been made martyrs to science and subjected to mixtures containing carbonic oxide, which is the poisonous constituent of ordinary illuminating gas, and after their death their blood has been examined and the amount of carbonic oxide absorbed by the blood determined. Grehant made comparisons of carbonic oxide and acetylene, to determine their relative poisonous qualities, upon dogs. In his experiments he used 20 per cent. of oxygen in mixtures, so as to prevent the animal's death by suffocation. He added enough Paris illuminating gas, which contains 7 per cent. carbonic oxide, so as to give 1 per cent. carbonic oxide in the mixture. The dog showed signs of suffering after three minutes and in ten minutes the dog was very sick, and his blood showed 27 volumes in 100 of carbonic oxide. Another dog was subjected to a mixture containing 20 per cent. oxygen and 20 per cent. acetylene, and the dog breathed without inconvenience for 35 minutes. Upon examination his blood showed 10 per cent. acetylene, less than 1/2, the rate of absorption of carbonic oxide. The mixture contained much more acetylene than that to which a person could be subjected in the use of acetylene as an illuminant, since a leak of the gas would produce an explosion in the room of a dwelling house before the percentage of acetylene mentioned were attained in the atmosphere. Similar experiments were carried on by Brociner, Berthelot, and Claude Bernard, and the conclusion of the best authorities indicate that acetylene when pure is not poisonous. Berthelot has pointed out that the old method of preparation of acetylene by means of acetylide of copper may contaminate the gas with hydrocyanic acid, and thus render it poisonous.

Power:	
4,320 kilowatt hrs. at .317 cent per kilowatt hr.	$13.69
Materials:	
2,085 pounds of lime at $5.00 per ton	5.21
1,339 pounds of coke at $2.50 per ton	1.67
Carbons:	
Carbons for 4,320 kilowatt hrs. at .18 cent per kilowatt hr.	7.78
Supervision and Labor—Operating 2 shifts, 12 hrs. each:	

1 Superintendent,	at	$5.00	$5.00
1 Chemist,	at	4.00	4.00
2 Foremen,	at	2.50	5.00
10 Regulating men,	at	1.00	10.00
6 Furnace men,	at	1.50	9.00
2 Grinders,	at	1.50	3.00
6 Laborers, handling, grinding and mixing,	at	1.50	9.00
			$45.00

Labor per ton, 45 ÷ 10	4.50
Cost of barrels and preparing carbide for shipment	1.00
	$33.85
Interest at 6% on $25,000, the investment necessary to erect the factory, furnaces, crushing and mixing machinery, apparatus for handling and regulating ... $1,500	
Depreciation on $25,000 at 5% ... 1,250	
Taxes at $10 per $1,000 ... 250	
Insurance at $3 per $1,000 ... 75	
$3,075 per ton,	.84
Cost of production at Niagara	$34.69
Freight from Niagara to New York, Philadelphia, Boston or Chicago, at 15c. per 100 pounds	3.00
	$37.69

Having seen how the calcium carbide and acetylene are made and having considered their properties, the question now before us is the cost of producing them. The results of the tests made at Spray, and before described, show that 8.3 pounds of carbide is produced by each electrical horse-power in one day, or .433 pounds per kilowatt hour; also that the efficiency of production was 58.4 per cent. Experience at Spray shows that the carbons used as electrodes last about seventy hours with the same amount of energy as used in this test. The cost of these carbons is $2 each, which approximates six cents per pound, or 18 cents per kilowatt hour. The cost of lime I have put at $5 per ton and coke at $2.50 per ton, these figures being about the average prices for these materials of good quality, and considerably less than the actual cost of them at Spray. The question of the cost of electrical energy is the all important one, so that I have taken the Niagara price of $20 per electrical horse-power per year of 8,760 hours, considering this to be the lowest commercial price obtainable at the present time, and one which offers no question as to its accuracy, it being one which is absolutely tangible. The estimate is further based on the assumption that the carbide plant is to be operated at full load 24 hours per day and 365 days each year, so that the actual cost per electrical horse-power hour of energy consumed may not exceed $20 divided by 8,760, which is .238 cent, or .317 cent per kilowatt hour. With this data as a basis the cost of producing one ton of calcium carbide at Niagara Falls, in a plant having ten 200 kilowatt furnaces producing ten tons of carbide per day, would be as above.

The estimate of cost per ton of calcium carbide is intended to represent the cost of manufacture to a large gas company operating in New York, Boston, Philadelphia or Chicago with its calcium carbide works at Niagara, and whose business would be to produce acetylene from the carbide in the city where the gas is to be used and to distribute it to its customers through its existing mains. It is not intended to represent the cost cleared off its books of any corporation or firm whose sole business would be the manufacture of calcium carbide for the market, for to cover that case we must add to the above estimate the cost of general expense, including administration, royalties, and selling expenses which of necessity would be equal to a large percentage of the factory cost as given.

Let us then consider the value of acetylene to the gas companies in large cities. In many articles and circulars treating of this question, it has been customary to place the actual cost of acetylene as produced from the carbide, taking the factory cost of the carbide as a basis, against the selling price of illuminating gas at $1 per 1,000 cubic feet. This, of course, is not a fair comparison and is very misleading. Believing that the only fair way to consider the relative value of acetylene and water gas is to compare them upon the basis of cost per candle-power hour in the holder, and assuming that the cost of distribution is the same in each case, I will treat the question on that basis.

We have seen from the results of the tests at Spray that for each pound of carbide we obtained 5.24 cubic feet of acetylene, or 10,500 cubic feet per ton; therefore, the cost per 1,000 cubic feet of acetylene would be one-tenth the cost of one ton of calcium carbide. The candle-power of acetylene being placed at 240 for each 5 cubic feet of gas, and the candle-power of water gas in the large cities at 25 for each 5 cubic feet of gas, it will be seen that the candle-power of acetylene is ten times that of water gas per 1,000 cubic feet, and, therefore, the cost of acetylene giving the same candle-power as water gas would be equivalent to water gas at a cost per 1,000 cubic feet equal to one hundred of the cost per ton of the calcium carbide. For example, if the calcium carbide costs the gas company $100 per ton then the cost of acetylene gas in the holder will be equivalent to 25 candle-power water gas costing $1 per 1,000 in the holder.

The present average cost of illuminating gas in the holders of the large gas companies approximates 30 cents per 1,000 cubic feet, while the cost of acetylene gas in the holder with calcium carbide at $37.69 per ton would be equivalent light for light to illuminating gas at 37 7/10 cents per 1,000 cubic feet, making the cost per candle-power hour of pure acetylene approximately 20 per cent. higher than that of ordinary illuminating gas. If acetylene were mixed with air and distributed, the cost would be less. This has been done in an experimental way, using 60 per cent acetylene, and 40 per cent. air, but the advisability of attempting to distribute such a mixture through a system of mains in a city for commercial use is exceedingly questionable, owing to the risk of the mixing being improperly done and the quantity of acetylene falling to such a percentage as to form an explosive mixture.

It has been suggested that the cost of distribution, as well as the cost of mains and maintenance, which constitute a large portion of the cost in the lighting industry, might be saved by the use of liquid acetylene, put up in cylinders and delivered to the stores, and residences, and offices so that the consumer might generate his own gas as required. It appears to the writer that this method is an entirely impracticable and uncommercial one, as there are almost insurmountable objections to be overcome. Neither the average business man nor the

occupants of a residence wish to be bothered with the care necessarily attendant upon the use of the cylinder of acetylene. It would be necessary either to have two cylinders ready for service or to have a second one placed in service before the first one were exhausted, and in all probability the busy man would find himself in darkness at the time when he most needed the light, owing to the fact that he had neglected to renew his cylinder. The pressure of the gas in these cylinders is from 600 to 700 pounds, so that it is necessary to use a reducing valve which will give a presssure of one ounce. The same valve which is used with the Pintsch system of railway lighting is employed, but this in all probability would not be kept in condition by the ordinary householder or storekeeper, and the consequence would be that the full pressure might be impressed upon the pipes, and in case this were prevented by the use of an auxiliary safety valve, then every failure of the reducing valve would allow all the gas to escape and be lost. The use of acetylene cylinders would increase the danger in case of fire, since the gas would escape should the cylinders become heated and explosions of the mixture of acetylene gas and air would possibly follow. After considering the many inconveniences and dangers in the use of liquid acetylene in the business and residence district of the large cities, it leads the writer to believe that acetylene to be commercially successful must be delivered to the customers in the form of gas through a system of mains, as is done now with ordinary illuminating gas. Liquid acetylene should find a field in the lighting of country estates, railway trains, and for use in carriage, bicycle, and locomotive head lamps, and in isolated places where distribution by mains is not possible.

When acetylene was first brought forward to be used commercially, it was expected that the gas companies might still maintain their existing gas works and use acetylene to enrich their gas and furnish a 25 candle-power flame as formerly, but at a much less cost. Experiments have shown, however, that although coal gas may be enriched by acetylene, water gas is not susceptible to enrichment by it. Water gas, which is furnished in nearly all the large cities, has little illuminating power of its own, is now treated with petroleum, and it is only when enriched to a certain candle-power that acetylene may be mixed with it without losing its candle-power, so that we cannot, as at first supposed, substitute acetylene for petroleum and use it economically as an enricher of low candle-power water gas.

It has been suggested that the manufacture of calcium carbide might be carried on by central station electric lighting companies as a by-product, furnishing the energy necessary for its production during hours of light load upon the lighting system, thus bringing the load curve of the station nearer to a straight line and thereby improving the economy of the station operation. It will be readily seen from the figures given in the estimate of the cost of producing the carbide, that the cost of power is a very important factor, and if we increase the cost given, of $20 per horse-power per year, we will correspondingly increase the cost of the carbide. From experience with the cost of operation of the largest central lighting stations in this country, the writer can safely state that the absolute cost of fuel alone in the most economically operated lighting station of the most modern type of multiple expansion condensing plant averages .3 of one cent per kilowatt hour, or approximately $20 per horse-power per year continuous service, while the total cost of generation in the station would average over double that amount.

In the average of the large central stations the generating cost at the switchboard, without distribution and general expenses, approximates one cent per kilowatt hour, which is about $65 per horse-power per year, and in the smaller stations using steam, double that amount. It is obvious then that we may not hope to use our present central stations during minimum hours for the manufacture of calcium carbide as a by-product while the cost of power in our stations remains as it is at present, and the amount of power required for the production of carbide is so excessive that the cost of its production by the central station would be prohibitive. It would be much better and more economical for the central station manager to sell his electrical energy through the incandescent or arc lamp at the same price per kilowatt hour than to use the energy for the production of carbide, since the cost per candle-power hour would be less when the electrical energy is converted into light directly through the incandescent and arc lamps than through calcium carbide and pure acetylene, assuming the cost of distribution and general expense to be the same in each case.

Take, for example, carbide at $40 per ton, which means 40 cents cost per 5,000 candle-power hours of acetylene gas in the holder, or 125 candle-power hours for one cent. Compare this with electrical energy at the switchboard at two cents per kilowatt hour. For each kilowatt hour generated we obtain twenty 50 watt incandescent lamps, each giving 16 candle-power, making a total of 320 candle-power hours per kilowatt hour, or 160 candle-power hours for one cent, which is 28 per cent. more candle-power for the same expenditure of money by the use of the incandescent lamp directly as a converter of electrical energy into light as against the conversion by means of carbide of calcium and acetylene.

If we take the case of the arc lamp and add to the cost of the electrical energy 1.5 cent per kilowatt hour for carbons, trimming and lamp repairs, making the total cost 3.5 cents per kilowatt hour, we find it still more advantageous. Assuming a 500 watt arc lamp gives 1,000 candle-power, we have 2,000 candle-power hours per kilowatt hour, or 575 candle-power hours for one cent, which is 4.6 times the illumination for the same money as compared with pure acetylene gas.

Taking the cost per kilowatt hour at the switchboard in the large central stations, we obtain 320 candle-power hours for one cent, which is 156 per cent. more candle-power for the same expenditure of money by the use of the incandescent lamp directly as a converter of electrical energy into light as against the conversion by means of carbide of calcium and acetylene.

By means of the arc lamp on the basis of cost of one cent per kilowatt hour for electrical energy and 1.5 cents per kilowatt hour for carbons, trimmings and lamp repairs, we obtain 800 candle-power hours for one cent, or 6.4 times the illumination for the same money as compared with pure acetylene gas.

From these deductions and considerations, it may be concluded in the light of our present knowledge and upon the basis of the estimated cost of production of the calcium carbide, acetylene gas should not drive the incandescent and arc lamp from the lighting field; neither should it make such inroads on the electric lighting business as to materially affect the earnings of existing central station companies, for after all, acetylene is a gas and burns with a naked flame, and the use of incandescent and arc lamps has steadily increased year by year, not because of their cheapness, but because of their infinite superiority as illuminants over any gas flame yet developed.

SINGLE-PHASE SELF-STARTING SYNCHRONOUS MOTORS.[1]

BY F. H. LEONARD, JR.

EVERY central station manager who operates an alternating plant has to grapple with the question of power distribution. Applications for power service come in from every direction, and in many cases, properly worked up, would make a more remunerative business than that of furnishing current for lighting purposes. It is, perhaps, unnecessary to point out that the bulk of the lighting service averages but a few hours per day, whereas the motor service covers a much longer period with a corresponding reduction in cost of the current output. The difference is so great that many stations are furnishing current for motor service at 50 per cent. of the price for lighting service, and, even then, figure that the motor business is the more profitable.

The drawback to the single-phase synchronous motor has heretofore been that it could not be started without some other source of power, and would not carry its load up to speed. Motors are now made in which this is entirely overcome. They start up under load, and can be specially wound to give much greater torque in starting than when running in synchronism.

Two simple, well known principles are combined in this motor: The principle of the ordinary alternating current synchronous motor with that of the direct current motor or generator. The armature has two distinct windings; one, a distributed winding connected to a commutator, similar to that of a direct current motor or dynamo, which in this motor is used for starting and afterwards for exciting the field. The other winding is of the shuttle type, wound so as to concentrate distinct and regularly alternating poles in the armature, and performs the regular work of rotating the motor armature, advancing it from one pole to the next, with each impulse of the generator.

An ordinary double-throw switch on top of the motor is used in starting, there being no resistance or other complicated device, as the self-induction of the windings is sufficient to choke back any abnormal flow of current. In starting, the switch-handle is depressed so that the lead wires which conduct the alternating current from the transformers are connected through the switch blades to the contacts which lead the current first to one of the commutator brushes, thence through the

[1]Read before the N. E. L. A., New York, May 5, 6 and 7. Abstract.

distributed armature windings and out through the opposite brushes to a coarse wire winding on the field poles and back again to the switch contacts and binding posts, these connections being identical with those of a direct current series motor. As soon as the current is turned on, the motor commences to rotate at a constantly accelerating speed until synchronism is reached, which is indicated by the lighting of a lamp located on the switch at a dull red. This is the signal for the reversal of the double-throw switch, which then changes the complexion so that the leads from the transformer are cut off from the commutator and connected to the collector rings and concentrated armature windings, while at the same instant the commutator brushes are connected to the shunt field windings, magnetizing the field with direct current, the only office of the commutator after the motor is started and up to speed being to supply the small direct current necessary to magnetize the field.

In starting without load, the motors will run up to synchronous speed in from five to fifteen seconds, depending upon size, windings, etc., and when loaded in from fifteen to thirty seconds, taking about the same current in either case, the time factor making the difference in the power consumed; the current taken under these conditions amounting to from 25 to 50 per cent. in excess of what the motor will require when running in synchronism. But when only required to start itself or light counter shafting, this current may be greatly reduced by special windings.

The direct current winding delivers a perfectly smooth current, and is not at all pulsating in character. In circuit with the field winding is a rheostat to control the extent of field excitation. This rheostat is located in a recess in the base of the motor, the handle for its regulation being accessible through the oval opening at the commutator end pedestal. The motor, starting switch and field rheostat are in one piece, making a most simple and compact combination. All that is necessary to install the motor is to connect the secondary wiring of the transformer to two binding posts on the motor, and it is ready for operation.

The field crown is of the multipolar type, with field cores pointing inwardly; the magnetic circuit is composed of sectional sheet iron punchings, each section including two poles, stacked so as to break joints. These punchings interlock and are clamped between two cast iron rings with bolts passing through from side to side, which serve to clamp the whole together solidly, at the same time holding each punching in its proper place and tying them like links in an endless chain. The bottoms of the cast iron rings are milled to fit the base of the motor, to which they are firmly bolted.

On top of the field crown is placed a starting switch, and all the electrical connections from fields, commutator and collector brushes are brought around the outside of the field punchings to the top, concealed from view, however, by the perforated steel jacket, which is held in place by grooves in the cast iron clamping rings, forming an ornamental finish and greatly increasing the radiating surface.

As this motor runs at a constant speed, it has been necessary to devise several arrangements to accomplish what might be done by variable speed motor. Motors are made for blowing church organs, in connection with which it has usually been customary to provide complicated automatic speed regulating devices. With this motor no attempt has been made to vary the speed. The organist closes his circuit and starts his motor by means of a pedal. A blower, driven by the motor, fills the bellows and maintains a constant pressure, usually about four ounces per square inch. If no air is used, the blower spills the wind out of its fan and requires only enough power to overcome the friction and maintain the pressure. As fast as the air is used the blower takes a corresponding amount of power, the motor absorbing the current accordingly.

An arrangement for elevator service which is extremely simple has been devised. The constant speed alternating motor, cable drum and gearing are all mounted on a single base casting, in which the respective parts are bolted. There is a pinion on the shaft of the motor which engages two bevel gears, each mounted on a sleeve, which also carries one part of a friction clutch, the two sleeves rotating in opposite directions, and the whole being supported by and turning freely on the worm shaft which engages the worm-wheel that turns the cable drum. The other part of each clutch is keyed to the worm shaft. The controller wheel is mounted on an extension which is cast on the case that entirely incloses the bevel gears and pinion, permitting them to run constantly in oil. This controller wheel is connected to the controller cables or hand ropes which serve to operate the elevator. A pull on the hand rope turns the controller wheel, rotating it through an arc of 60 deg. This rotation serves, first, to release the brake on the worm shaft, by means of the adjustable link and lever, by depressing the roller which travels over the cam in the controller wheel; at the same time, one shipper fork is moved by the connecting rod at its upper end, which is pivoted near the upper rim of the controller wheel, far enough to cause one of its clutches to engage its other part on the sleeve attachment to the bevel gear, so as to drive the worm shaft and rotate the cable drum. At the same time, the connecting rod attachment to the shipper fork opposite moves across the center of the controller wheel without producing more than enough movement to take up the lost motion in the clutch parts to which it is attached. Pulling the hand rope in the opposite direction brings the parts back to their original position, disengages the clutch, and sets the brake on the worm shaft. Pulling still further in this direction, the opposite connecting rod travels so as to move the shipper forks and engage its clutch, turning the hoisting drum in the opposite direction, while the first mentioned connecting rod moves across the center without causing any appreciable movement of the shipper fork. The motor runs continuously in one direction during working hours, and there is no heavy rush of current in starting as with a direct current series motor, with its tendency to drop the brilliancy of the incandescent lights on the same circuit.

These motors are suited to any frequency in general use in this country, and are wound for from 140 to 60 complete periods per second, the speed being fixed by the frequency of the generator or circuit to which it is connected.

While this motor was designed for single-phase circuits, yet it is obvious that it will work quite as satisfactorily when connected to either leg of a two or three-phase circuit, and where such circuits are loaded with induction motors, a few synchronous motors properly distributed and somewhat over-excited would serve to allay the pernicious effects of the inherent lag or idle current which goes with induction motors, at the same time raising the e. m. f. at the extremities of the line, reducing the drop in the conductors and allowing the generators to do more work, inasmuch they would not be required to deliver so large a wattless current.

This synchronous motor is also a good rotary transformer, and lends itself very conveniently for charging storage batteries and electrolytic work, the alternating current entering at collector rings, while direct currents are delivered from the commutator brushes. For laboratory work and as a piece of apparatus in colleges that teach electric engineering it is invaluable; for, besides the previously mentioned uses, it may be driven by direct currents as a series motor; further, it may be run at a constant speed as a direct current shunt motor, while from the collector rings alternating currents may be taken at any frequency, dependent upon the speed, which can be regulated by resistance in the field or armature circuits; or belt driven, it may be used as a self-inciting alternator.

THE EVOLUTION OF THE ARC LAMP.[1]

BY L. H. ROGERS.

THE author first drew a rapid sketch of the early history of the arc light, beginning with the discovery of Sir Humphry Davy, tracing the successive steps of inventors to make arc lamps which would operate independently of one another when connected to the same machines, and the failures that were encountered down to the time of Brush, in 1875. He drew attention also to the fact that the lamp had not kept pace with the dynamo in the march of progress; and continued, as follows:

The Arc Lamp Must Meet the Demand.—Remember that the title of this paper is "The Evolution of the Arc Lamp," and that evolution denotes a continuous development. Since Brush perfected the fundamental principles of the commercial arc lamp, what has been done? In 1875 the arc lamp was a great ball of wonderment. In 1878 to 1880, a few were induced to really try them practically. During the next decade, the mad lighting fever was in full sway, and 250,000 arc lamps had been hung up in the United States by 1890. The manufacturing companies were too busy shipping and collecting to thing of anything but of something which would burn. The lighting companies were too busy making contracts with municipalities and supplying the demand for light to ever look to see what was inside the lamp.

But this is the age of close inspection. Municipalities are not paying $350 per year for a 2,000 candle-power arc lamp in 1896. They encourage other companies entering their city limits, and this brings keen and active competition. If competition is not encouraged, or if prices for lighting are not reduced, the taxpayer—that tireless individual who never dies—is heard from, and starts the agitation for a municipal plant on the theory of his new discovery that electricity costs nothing to "make."

[1]Read before the N. E. L. A., New York, May 5-7. Abstract.

It is not the purpose here to discuss this swing of the pendulum from too high prices—it has, indeed, swung too far already in the other direction—but it does behoove us to examine closely into the daily expenses and annoyances to which the electric lighting plant is subjected.

There is no business which has developed so rapidly and so radically as that of electric lighting. The frame building, 20 feet square, has been replaced by a handsome brick and iron-roofed structure, 150 x 300 feet, and three stories high. The deliberate saw mill engine, at 90 revolutions, has been replaced, first by the diminutive busy little high-speed engine at 350 revolutions, then by a larger type of the slow speed engine, and later by a compound condensing engine at a piston speed of 800 feet per minute. The transmitting devices have been changed from belt to rope, and rope to direct. The boilers have undergone a radical change, and the manufacturer must now guarantee the pounds of water evaporated per pound of coal by his make. Remarkable and needed improvements have been made in the dynamo, as we have mentioned. The efficiency has been raised from 50 to 85 or 90 per cent. A 125-light machine is less trouble and care to run than an old 10-lighter.

In all this development; this search for high efficiencies; in this attempt to get running expenses down to the minimum, the arc lamp has been overlooked. The most important single piece of mechanism in the entire system, it has been the last to receive serious attention.

There are 2,711 central lighting stations in the United States, with $320,000,000 invested. The sole and only object of this outlay is to get light. The engines, dynamos, belting, conduits, buildings, are all secondary to the arc lamp. It is the exponent of the entire problem. It is literally in the "eye of the public" day and night. Its lines of—I was about to say beauty, but who ever heard of a beautiful arc lamp? At any rate it stands against the morning sky, or the evening sunset, and in truth, I hear the public say, "It must be the best the electricians can do, for I have watched for fifteen years, but have seen no change; they are all alike in their hideousness."

And now, let us look at the subject squarely. Let us hold the arc lamp up between the fluorescent screen and the Crookes tube, and in the light of X-ray, '96 knowledge, examine the arc lamp hanging in our streets.

We find a device 50 to 60 inches long, made of long tubes, or chimneys, a sheet iron drum, long side rods, and at the bottom a globe-holder. We can see Davy's two pieces of charcoal—one is 12 inches long, and the other six, the rate of consumption has not changed. We realize that the useful length of this lamp is the vertical length of the carbons. Dividing 18 inches by 50 inches we find that the useful length of this device is only 36 per cent. of its total length. The statement may be made by some enthusiastic observer that there are two pairs of carbons, one pair alongside the other, but he must not forget that with our improved eyesight in '96, we can look clear through the device, and see not only the skeleton, but the marrow in the bones.

These carbons are fastened firmly in their respective holders, and the holders are rigid. The burning of the arc causes the carbons to point up quite decidedly. When the current is shut off momentarily, these points fall together, and it very often happens slip by each other and wedge. When the current is again sent through the coil, its lifting power is not sufficient to pull the carbons apart, the lamp is rendered utterly useless—the policeman reports it out, and a deduction is made from the bill of the lighting company to the city. To prevent these deductions, amounting to more than the original bill, a corps of patrolmen are engaged, whose business it is to watch the lamps all night long, to prevent them going out, as a nurse would watch a sick child.

We find the interior of the device full of springs—some of them with ratchets and cog wheels, some with six magnets or coils, all with three or more; springs without number, and of every size, regulating devices, auxiliary levers, light and flimsy pieces of every shape and size, the device for gripping the rod in most cases an annular ring gripping the carbon rod by tilting so that its knife edge holds on the side of the rod, the current being conducted to the carbon rod by means of a sliding contact, delicate brushes against which the carbon rod rubs as it feeds the carbons downwards, cut-out spools which have little shows of their own with independent armatures, and additional coils of wire, carbon rods sticking away up into the dark recesses of the chimneys, rods which must be carefully housed and carefully cleaned with crocus cloth each day. We notice also that for three or four inches above the casing the rod cannot be cleaned by the trimmer; it therefore becomes spotted; a bit of weather or a bit of dust changes the nature of the brass, and the current carrying brush when it reaches this spot does not make a good connection, a little blister is formed, which in turn blisters the surface of the brush, and this in turn blisters the rod the entire length until crocus cloth is powerless to smooth it. The lamp then must come in, for in the mean time many other little things have happened, and nothing but a thorough overhauling will put the lamp in good condition again.

It would require a volume to recount the details of the troubles that are occurring every hour, in every lighting plant on the face of the globe. You, who are within reach of my voice, know too well that your arc lamps give you more trouble than all the rest of your apparatus combined. These troubles have come upon you so gradually, however, that you have become accustomed to them. It seems that some station men actually delight in keeping a force of men repairing old lamps, and a horse and wagon busy hauling them in and taking them out again.

Alexander Dow, electrician for the city of Detroit, connects four 100-light dynamos to one engine, for the reason, as he states, that the ratio of troubles is 4 to 1. I wonder how many dynamos would be connected to each arc lamp, or arc lamps to dynamos, provided the number were dependent on the ratio of troubles?

And now, we have reached the year 1896; we have given the arc lamp a 20 years' tussle, and our troubles are increasing rather than diminishing. The lamp cuts the same kind of a figure against the sky, as it did in the year 1875. Many details have been added in the interior construction—more magnets and more springs and more cut-outs and more chimneys, and less glycerine, but I do not think the statement can be denied that not one single idea of great merit has been added to the arc lamp between 1875 and 1895.

If this be true, is it not time to consider the question seriously? Are we to give up the question, and acknowledge that, hanging on our streets, is the world's best effort for the distribution of light through the medium of the arc lamp? Is evolution to be the password to progression in all the arts, in fact, in everything except the arc lamp?

To return to the opening sentence of this paper, "For the purpose for which it is intended to be used, the arc lamp as we commonly know it, is, mechanically and electrically, the poorest designed and constructed piece of mechanism on earth."

I am not here to decry the lamp of any manufacturer. It is, however, pertinent to say that any lamp which will allow the carbons to slip by or wedge, under any circumstances, is mechanically imperfect. It is an inherent defect in the lamp, and the damages or outrages should be charged to the manufacturer of the lamp. What mechanism has determined that the proper way to hold two slim, sharp-pointed pencils in a coaxial position is to fasten them rigidly at their extremities, 18 inches distant, and then depend on their sharpened points nosing each other correctly? A very much better way would be to leave the carbon holder loose and free, centering by guiding the carbons near the arc. This would make trimming a very easy matter, and admit of cross-eyed men being employed. On second thought, however, we run immediately into difficulties, for, as we cannot change the rate of consumption of the positive carbons, the arc would soon reach one of the guides and burn it away. This would then require a lamp with stationary arc, and that would require carbons of different diameters—upper and lower—and that would mean a great deal of thinking for the inventor and manufacturer, and so the lamps go out, and the station manager, believing that the arc lamp has been fully evoluted, keeps sending his orders to the manufacturer, and the manufacturer will never improve as long as he can fill his orders with old-style apparatus.

A sliding contact is a poor arrangement in an arc lamp. It has been tried as thoroughly as any idea ever could be tried. It is the direct cause of the roughness of the rod. The resistance of the contact is too easily increased by the presence of a little dust. The sliding contact in the arc lamp must go.

The carbon rod itself is a troublesome institution. With an annular ring for a clutch, it must be kept in a uniform polished condition, or it will give trouble. It is responsible for the unsightly, hideous chimneys, which ought not to be in sight, and yet which cannot be draped. As we are building a new lamp let us dispense with the carbon rod altogether. We can then cut off the chimneys, and shorten up the lamp. Then we can, without much trouble, parallel the carbons with the operating mechanism, and increase the percentage of useful length to total length to at least 80 percentage. With a short lamp we can make a casing of light cast iron in such shape as to avoid the necessity of a hood. We can also increase the carbon length, and if we do this, we can choose our own size of carbons—that size for upper which will produce the largest crater, and that size for lower which will best let the light out.

Thus we come back and meet, but overcome, our first difficulty. We construct a focusing lamp, and this leads us to the thought that there is only one correct position for the arc

inside the globe, anyway, and that the arc should be stationary. If we hang the upper carbon on a chain suspended over a sheave, and attach the lower carbon to the lower end of the chain, we can, with proper adjustment, accomplish many things. As the upper carbon feeds downwards as it is being consumed, the chain can be of equal weight—inch for inch therewith. Therefore, when an inch of upper carbon has been consumed, and its weight taken from the cross head, an inch of chain has been added, and the armature remains in the same plane between the pole pieces of the magnet as before. This is an absolute necessity where the same difference of potential is required throughout the entire range of burning.

Thus, we are not restricted by the weight of the carbon, and can use whatever size is most suitable. It having been demonstrated that with 8, 9, or 10 amperes, two ⅝-inch carbons will produce a larger crater and give more initial light than any other size, it remains only to determine the length necessary for burning 14 to 16 hours. This length has been found to be 14 inches. With an upper carbon of ⅝ inch x 14 inches, we find that ½-inch x 12-inch negative plain will burn an equal length of time, leaving an equal stub and keep the arc practically in the same position during the entire run. This small lower carbon will let out the intense light in the crater of the upper—the increase of light at 45 degrees being something which would astonish most experimenters.

We must not forget that 320 millions of money is invested in the central stations alone in the United States, simply to get light and more light with the same expenditure of energy should be a welcome statement by those interested.

By quotations from all leading carbon manufacturing companies of the country, the point is discovered that a pair of ⅝-inch x 14-inch and ½-inch x 12-inch carbons is the cheapest possible combination for 14 to 16 hours' burning. Any one can test this point. It is simply the price of one ⅝-inch x 14-inch plain and one ½-inch x 12-inch plain carbon against three ½-inch x 12-inch plain or 7-16-inch x 12-inch copper-coated carbons. I have quotations in my pocket which will make a difference of $2.50 per lamp per year, assuming the full number of burning hours nightly, in favor of the ⅝-inch x 14-inch and ½-inch x 12-inch carbons.

Again, a ⅝-inch upper and ½-inch lower, loose at the joints and guided near the arc, will absolutely prevent wedging or slipping by, whether the lamp be shunt or differential.

I quote from a recent article by Alex. Dow, of Detroit: "In the plant I operate, analysis of the 'outs' for two months showed that lapping was responsible for too much of the total trouble. We were running with 7-16-inch carbons in both holders. We changed to ⅝-inch uppers, retaining the 7-16-inch lowers. Results for four winter months' operation of 1,480 street arcs, is just one 'out' by lapping." Mr. Dow is ahead of the lamp he tried to fix. He neglected to state that he was compelled to break his ⅝-inch carbons off so that the weight would be more than a 7-16-inch x 12-inch. This lamp was not designed on evolution ideas. A heavier weight in the upper carbon holder would position the armature in a different plane as regards the operating magnet.

The double carbon lamp has outlived its usefulness. It filled a gap for a few years. Its only recommendation is that it will burn all night long. Its drawbacks are numerous. More mechanism is required: Two carbon rods with two sliding contacts. The arc is struck well up near the top of the globe at one side—not in the center—and travels downwards. This causes an uneven heating of the glass, which results in globe breakage, especially in severe climates. I have known a number of superintendents who always took the precaution to crack their globes with a soldering iron before putting on, then by putting on a net, the unequal expansion and contraction were overcome.

Never losing sight of the fact that the function of an arc lamp is to diffuse light—as much light as possible, and in every direction possible—any unnecessary opaque substance which is interposed between the arc and the surrounding space to be illuminated, shows a defect which is simply monstrous. With one pair of carbons burning 16 hours, we need have only one single arm of small cross section reaching down to sustain the globe holder. The shadow from this arm can be thrown directly against the pole or building, leaving absolutely unobstructed light for the street. We can arrange the trimming to be done quickly and without touching the globe. The globe can be cleaned without removing.

It is a very noticeable fact that those who have had the most intimate acquaintance with arc lamps and have operated practically the largest lighting stations for the longest time are the men who are the most eager to hear of a lamp constructed on new principles.

The West Side Park, Chicago, is about purchasing a large arc lighting plant—one of the largest ever installed at one time. They want 750 arc lamps. The specifications drawn by their engineer, Mr. Forée Bain, reached me a few days since. They are sufficiently unique to be preserved. His idea, I think, is new. He asks a number of questions. The bidder is to answer these questions on blanks furnished, said answers to form the guarantees of the bidders.

These specifications read, as follows:

Single or double carbon? Size of carbons? Upper, ...? Lower, ...? Cross section? Market price of such carbons per 1,000? Length of time the lamp will burn with one trimming, in circuit of 9.6 to 10 amperes and a difference of potential of 45 or 50 volts at terminals of lamps? With 6½ amperes and 45 volts? Will the lamp burn at a practically constant voltage of 45 to 50 volts while the current may be changed from 9.6 amperes to 6½ amperes? If not, what range do you guarantee? In stating guarantees above, do you refer to the use of plain or plated carbons? State make of carbons referred to. If such carbons are covered by patents, making them a monopoly, state price per 1,000 you hereby guarantee they will not exceed for a period of five years from date hereof? By what means are the carbons adjusted to a coaxial position? By what means are they maintained in a position coaxial with regard to each other? What is the extreme length of lamp? What is the weight of lamp with globe, trimmed and hung ready for operation, with hood and hanger board, if such be necessary? How many side rods for supporting the globes and negative carbons? Diameter of each intercepting the rays from the arc? Length? Is it necessary to remove or disturb the globe when trimming the lamp? Does your lamp require a special globe? If so, what price do you guarantee they will not exceed for a term of five years from date? Of what material is the jacket or case composed? How removed for inspecting the operating mechanism? Is the lamp shunt or differential? After the arc is struck, is the series coil retained in circuit? Is its responsive mechanism in continuous active motion? What is the electrical resistance of the series coil and its connection? what is the resistance of the shunt coil? Of what size wire is it composed in decimals of an inch? How many active pivotal joints in operative mechanism? How many springs in the lamp? How many variable adjusting devices are there in the lamp? Are they sliding or pressure? Of what metal composed? Maximum current carried? Can they be readily replaced? Will the automatic cut-out re-establish the arc when the carbons come together? Within the limit of what number of volts can the cut-out be adjusted to positively operate? If a double lamp, what is the difference of voltage between two pairs of carbons when in normal operation? Is any resistance cut into the main circuit when the lamp automatically cuts off? How many ohms? What is the form of cross section of the carbon feeding rod? How is the circuit through the rod? What is the area of surface contact of the clutch with the rod in decimal of square inch? What are the voltage and current at which the lamp is best adapted to operate? State the maximum voltage between which the lamp will operate and feed in practical service, during a period of six months? Mention any special features of your lamp?

The man who could ask those questions is hunting for an arc lamp different from the ordinary. They show that he has fought and bled with a multiplicity of spools, springs, rods, sliding contacts, lapping carbons, broken globes, and rusty sheet iron cases, and that he has lived within the dark shadows thrown by the old style lamps, and gazed for years upon landscapes marred by the contours of the arc lamps of the period of 1875 to 1895.

REPORT OF THE COMMITTEE ON STANDARD RULES FOR ELECTRICAL CONSTRUCTION AND OPERATION OF THE N. E. L. A.[1]

THE report drew attention first to the preamble and resolution adopted by the committee under which the various electrical, insurance, architectural and kindred interested bodies were invited to a joint meeting to discuss the subject, which is already familiar to our readers, and which led up to the conference held in New York, March 18 and 19, of this year. The report continues as follows:

Captain Brophy, by the request of your committee, had prepared and read a paper on the history of attempts at formulating standard rules by the National Electric Light Association and others, and your committee respectfully suggest that this paper be printed as accompanying this report, believing a record should be thus made of the important part played in the past by this association.

Your committee also submitted to the conference, as a basis for the discussion, a pamphlet containing the codes of rules which are largely in vogue in this country and abroad, emanat-

[1]Presented at the convention of the N. E. L. A., New York, May 5 and 7, 1896. Abstract.

ing from the following organizations: National Electric Light Association, National Board of Fire Underwriters, Associated Factory Mutual Insurance Companies, Phœnix Fire Insurance Company (English), and Board of Trade (English). Various other matters relative to American and foreign practice were presented at the conference, and after a most earnest consideration of the various codes and much valuable discussion covering a period of two days the whole matter was referred to the code committee of seven to prepare a final draft for submission to the next meeting of this conference, which was then adjourned to meet June 25 and 26, or subject to call of the chair.

Your committee feel that there is every reason to believe that the long sought for and much to be desired end is near at hand, and that the formation of the national conference upon standard of electrical rules will result in the near future in the adoption, promulgation and enforcement of one single recognized standard for electrical construction and operation; a standard code meeting fully the requirements and wishes of the electrical, insurance and allied interests of the country. Believing the interests of the National Electric Light Association will be conserved by the national conference, in which the association will doubtless continue its representation by an official delegate, your committee present herewith its final report and beg to be discharged.

Accompanying the report will be presented the voluminous correspondence of your committee and various other papers, three of the official code for the conference, full minutes of the conference held March 18 and 19, 1896, covering 179 pages of typewritten matter, and including Captain Brophy's paper, various committees' reports, etc., and thirty copies of the standard codes forming the basis of discussion at the conference.

In conclusion, your committee most strongly urge the association to continue its representation in the national conference, by the appointment at this meeting of an official delegate and the appropriation of a sum of money not to exceed $25 for carrying out the incidental expenses of the conference, other bodies contributing a like sum for this purpose.

William J. Hammer, chairman; Jas. I. Ayer, Harrison J. Smith, E. A. Leslie, Wm. Brophy.

ADDRESS OF PRESIDENT C. H. WILMERDING BEFORE THE N. E. L. A.[1]

MR. WILMERDING opened his address with a brief allusion to the history of the Association and referred to the history of the science as exemplified in the historical collection at the exposition. Referring to the rapid progress of the art he drew attention to the fact that since the World's Fair at Chicago in 1893, the world had been given Röntgen's discovery of the X-ray, the Tesla oscillator and Moore's vacuum tube light. He also referred to the transmission of the power from Niagara, which runs the Niagara model at the exposition, which traverses a distance of 462 miles, that is, 347 miles longer than the celebrated Frankfort-Lauffen transmission.

Coming to the commerical progress Mr. Wilmerding continued:

About seventeen years ago the first central station was established. At present there are 2,500 electric light companies in the United States and about 200 municipal plants. These central stations represent an invested capital of $300,000,000. There are, in addition, about 7,500 isolated plants, which have required the expenditure of $200,000,000 more. An idea of the capacity of these 10,000 installations may be formed when it is known that there are produced daily for their use from 50,000 to 75,000 incandescent lamps; that the annual consumption of carbons in arc lamps is 200,000,000, and that 500,000 stationary electric motors are operated by the current which they generate.

The electric railway is of still more recent birth, dating back but ten years, and yet at the present time there are no less than 900 such roads in this country, using 11,000 miles of track, operating 25,000 cars and involving an investment of about $750,000,000; and this investment is increasing annually at the rate of $100,000,000 for new roads and new equipment. While these are large figures, they do not at all represent the total capital employed in electrical industries. The manufacturers of the apparatus and supplies used to carry on this enormous business, and the dealers who handle them, have at stake probably a sum sufficient to build and equip all the central station plants in the country; and if the auxiliary enterprises, such as those of the producers of copper, the makers of boilers, the engine and car builders, fixture manufacturers, glass workers and a score of others, who depend in a large degree, and in some cases, exclusively, upon the electrical trade, are considered, the grand total would reach a sum that any country might be proud of as a national debt.

This astounding growth affords a striking example of American enterprise as compared with that of the Old World. Against 900 electrical railways in this country, there are less than 100 in all Europe; and as to electric lighting, the output of a single company in New York, or of a single company in Chicago, is greater than the combined output of all the stations in the brilliant city of Paris.

The short period since our last meeting has in itself marked an epoch of the greatest importance in electrical engineering, the Metropolitan, of Chicago, has been opened for public travel, and has already demonstrated that such a road can be operated at about one-half the cost of a steam road, and making it merely a question of time, and a short one at that, before all elevated trains must be propelled by the same cleanly and economical means.

The three first powerful electric locomotives of the Baltimore and Ohio Railroad have been put into regular service in the Baltimore tunnel, drawing the heaviest trains, and furnishing an example which other railway companies are already preparing to follow. This is undoubtedly the first step toward a general revolution in the methods of transportation which will result, not only in greater comfort and better service to the public, but in such a saving to the companies themselves as will place many a road, now on the verge of bankruptcy, on a prosperous and dividend-paying basis.

I am glad to be able to say that, while everything else electrical has been forging ahead, the National Electric Light Association has not been standing still. The reports which will be submitted by the Committee on Rules for Safe Wiring and the Committee on Data will show that they have accomplished much valuable work during the past year. The progress which has been made by the former committee toward bringing about the general adoption of a national code of rules for electrical installation is especially gratifying, and we may at last hope that this much-to-be-desired and long-deferred result of their labors may soon be attained. We have all suffered from the lack of fixed standards governing electrical construction and from the arbitrary rulings of self-constituted authorities on this very important subject, and the establishment of a board, composed of competent and representative men, whose rules will be consistent and, as far as possible, permanent, is one of the greatest of our needs, the realization of which should be one of the first aims of the association.

[1]Abstract.

PROF. ELIHU THOMSON BEFORE THE ELECTRIC POTENTIALS

LADIES' Night was celebrated by the "Electric Potentials" Wednesday, April 22, at the Thorndike, Boston.

The meeting was a great success in every way. There were about 100 ladies and gentlemen present. A reception was held previous to the dinner, and this was followed by a brief business meeting, at which twelve new members were elected. The officers for the coming year were also appointed, as follows: Frank Ridlon, President; G. W. Blodgett and H. F. Woods, Vice-Presidents; I. H. Farnham, Treasurer; Sydney Hosmer, Secretary.

After a most interesting résumé of the history of the Röntgen ray, glass globes were produced, their strucure explained, and the spots pointed out whence the Röntgen rays were flashed. As there were two different kinds of rays within the glass globes, it became necessary to use a sheet of lead to divide the one kind from the other. Having secured a globe that was in condition for producing the Röntgen rays, Professor Thomson proceeded to place two sensitive plates in a rubber hot-water bath. On this he placed a flat piece of wood, and on this another piece of wood into which a piece of wire twisted to form the word "Röntgen" was imbedded, the surface of the wood on the side next the wire being covered with a piece of pasteboard. This arrangement being subjected to the X-rays for a few minutes, the sensitive plates were treated by the usual photographic process of fixing and washing, when on being held to the light the word "Röntgen" was distinctly seen photographed on both plates.

Having briefly described the apparatus by means of which he transformed a low potential current to a very high one, and stated that it was possible to further increase the potential almost indefinitely, Professor Thomson proceeded to show by means of a powerful lantern impressions of his own, his assistant's, and his wife's hands, or rather the bones only, which were very distinct and utterly devoid of flesh, the rings on the fingers showing very prominently,

a diamond in one ring being quite transparent. Various fish, insects, reptiles, and other objects were also shown as reproduced by the Röntgen rays, all of which, in their weird and uncanny skeleton-like form created much interest in the audience, which, at the close of the address and experiments, gave Professor Thomson their hearty applause.

The occasion throughout was a notable one, there being present prominent and well-known electrical representatives from various parts of New England.

MR. H. L. FALK IS A FRAUD.

A FEW weeks ago, we published, with considerable caution and reserve, some alleged X-ray photographs of the brain taken by Mr. H. L. Falk, of New Orleans, who accompanied his data with references as to his truthworthiness. We hesitated to use the matter and did not do so until Mr. Falk sent us a further letter, asking for the publicity and recognition that were his due. Under these circumstances, with due disavowal of any faith on our part, we published his statements, "for what they were worth," but meantime sent to New Orleans and engaged a well-known scientist there to investigate the matter for us as fully as he could. We give his reply herewith, withholding only his name:

In regard to the so-called X-ray pictures of Mr. H. L. Falk, I do not hesitate to say that they are spurious, and that Mr. Falk is a perfect humbug. I went to his house and examined his apparatus and watched his work, and a more impudent impostor I never saw. Falk is an ignorant young fellow of about twenty-three or twenty-four years of age apparently, who has been an itinerant photographer and has dabbled a little in electricity. His apparatus consists of an old sixteen candle lamp and a medical "faradic" apparatus excited by five or six Edison-Lalande cells (so far as I could make out in the darkness under the table). He attaches one terminal of his secondary to the base of the lamp and then grasps the bulb with his hand and holds the bulb over the plate holder, keeping it in motion all the time. He gets the ordinary Geissler effect of a whitish glow in the bulb, but no trace of phosphorescence on the glass. I prepared a number of simple objects in a pasteboard box for him to photograph, but he was unable to do so. We made a number of tests, all of which showed that he was humbugging. Finally, one of the party, a prominent young physician, asked to have his brain taken, and after Falk had "prepared the plate" the young physician told him he would lie on his back and get that view. While Falk was going through his trick of moving the bulb all around above his head, he put his hand on his forehead, and left it there while the operation lasted. On development (I keeping the plate in sight until the development was complete and a friend of mine keeping his hand on it all the time), there appeared a side view similar to the one that I see published in The Electrical Engineer of April 29th! Every one present was convinced that the experimenter was a fraud.

I think the man places a drawing in contact with his plate while in the dark room, draws the shade from his lamp for a moment and makes an impression with ordinary light before bringing the plate out. He requires that he should be informed in advance exactly what is to be taken, claiming that the plates must be specially prepared for each picture. He is thoroughly untruthful. His statement was that his photographs were taken with wet plates and that his secret was in their preparation. To test this I drew the slide of the plate holder in the dark and found an ordinary dry plate. Falk never saw a Crookes tube, nor an X-ray negative. I invited him to come to my laboratory and see the apparatus, but he never put in an appearance. What his object is in this falsification, I do not know. I have not exposed him publicly, as I thought he would make no further pretensions after that evening. His audacity seems unbounded.

MR. D. M. STEWARD, the president of the Chattanooga Chamber of Commerce and manufacturer of lava insulators and other celebrated specialties, has been traveling in Europe, and is sending home some very interesting letters to the Chattanooga "Times." His enthusiasm over Scotland shows pretty clearly which side of the border he and his ancestors came from. We venture to believe he strikes the Scots as a fine type of American.

LITERATURE.

"DIE ANKERWICKLUNGEN UND ANKERKONSTRUKTION DER GLEICHSTROM-DYNAMOMASCHINEN" (Armature Winding and Armature Construction of Continuous Current Dynamos), by E. Arnold. Berlin, 1896, J. Springer, second edition, 312 pp., 5½ x 8. Price $3.

The present volume is an extension of the author's previous work on a subject which must always be of interest to the designer of dynamo-electric machinery. In glancing over the pages we notice a departure from the treatment which the subject has received in the first edition; thus, in the latter, the author divided armature windings into those having parallel, series and mixed windings. Further study has shown that a better classification is possible, in so far as the mixed windings can be divided into a number of parallel and series parallel arrangements.

The second part of the work, relating to armature construction, has been greatly enlarged, as compared with the first edition, and with much benefit to the reader. The author treats the subject by no means from the academic standpoint, but has introduced the valuable feature of accompanying all detail drawings by scales of dimensions, so that the student and designer is able to draw the greatest benefit from the illustrations. The work is profusely illustrated, and contains information on the latest types of machines. Its entire get-up is most creditable, and in its way it is among the best of its kind which has yet come under our notice.

"COMPUTATION RULES AND LOGARITHMS WITH TABLES OF OTHER USEFUL FUNCTIONS," by S. W. Holman. New York, 1896, Macmillan & Co., 73 pp., 6½ x 9½. Price $1.

It is one thing to have a set of tables of logarithms, sines and other trigonometrical functions and another to be able to use them properly. It is the author's intention to put into the hands of engineers and laboratory workers a set of tables which, without being too cumbersome, will permit of the carrying out of computations with sufficient exactness for all, except, perhaps, those undertaking astronomical work, and for that purpose he has limited his logarithms to five places of decimals, which, as he quite properly contends, effects considerable saving in time where numerous calculations are required. Perhaps as valuable as any part of the work are the 45 pages which the author devotes to explaining the use of the various tables. This is a boon, not only to those who have heretofore been without knowledge on the subject, but even to those who have become a little rusty on the subject from long disuse of such tables. The author gives an actual example, worked out, illustrating the use of each table. At the end of the work we find a résumé of the physical constants of nature. The tables are set up in large, clear type and printed on heavy paper.

"TRANSFORMATOREN FUER WECHSELSTROM UND DREHSTROM" (Transformers for Alternating and Polyphase Current), by G. Kapp. Berlin, 1895, J. Springer, 205 pp., 5 x 8. Price $3.

While there are works on dynamo electric machinery a-plenty there is, strange to say, little independent literature on transformers, which is all the more strange, considering the important place which this type of apparatus now occupies in electrical distribution. It is, therefore, gratifying to note the appearance of a work especially devoted to this subject, and the more so when the subject is handled by so able an engineer as Mr. Kapp.

The author has treated the subject from the eminently practical standpoint. Beginning with the general theory of transformers, he carries us through the methods of construction, showing the best distribution of copper and iron, both as to efficiency and cost of material, not neglecting those small details of construction which so frequently are the making or the marring of a piece of apparatus intended for hard usage. Special chapters are devoted to the testing of iron intended for transformers, as well as for the final output and efficiency tests of the completed apparatus. A chapter is also devoted to the methods of equipping transformer sub-stations, which is accompanied by a number of useful diagrams, as well as to methods of regulation of transformer circuits. The final chapter is devoted to the description of the latest types of two and three-phase transformers, especially the latter, many of which are accompanied by detailed drawings. The part devoted to the calculations is well within the grasp of those of limited mathematical knowledge, while even those lacking the bare elements will find in the work much useful information. We hope that the promised English translation will soon make its appearance.

MISCELLANEOUS.

THE JACQUES CARBON CONSUMING PRIMARY BATTERY.

IN our issue of March 11, we described a primary battery invented by Dr. W. W. Jacques, of Boston, in which the positive element, that is, the one consumed, is carbon. This cell is shown in section in the accompanying diagram, Fig.

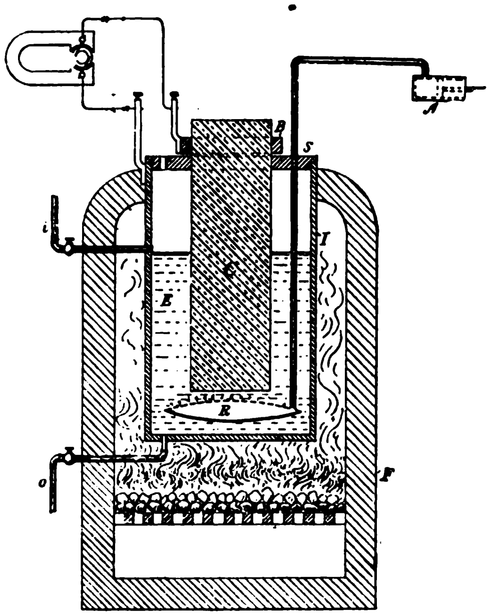

FIG. 1.—THE JACQUES CARBON CONSUMING PRIMARY BATTERY.—SECTION.

1. The carbon, C, is immersed in a caustic soda solution, E. A pump, A, forces air into the rose, R, which distributes it evenly into the electrolyte. The solution is contained in the Norway iron pot, I, which forms the positive terminal, the negative, B, being clamped to the carbon, C, which is supported by the insulating cover, S. The caustic soda solution is admitted and removed by the pipes, i and o. The whole is surrounded by a furnace, F, which maintains the active cell at a temperature of 400 to 500 degrees Centigrade.

The accompanying illustration, Fig. 2, shows a corner in Dr. Jacques' experimental laboratory. An early form of the carbon electric generator, which has now been in operation for six months, is seen to the left, the tops of the 100-cell battery showing, with their connections. To the right of this is the air pump, driven by a portion of the current generated, and above it, on the wall, part of the electric lamps operated. The two switches on the small shelf are used, the one for switching that portion of the current used for the pump, the other for cutting the lamps in and out of circuit. The cells consist of iron pots 12 inches deep and 1½ inches in diameter.

In a recent test made by Messrs. Stone & Webster, of Boston, the apparatus illustrated maintained 30 16-candle-power lamps at full brilliancy. It was found that to maintain these lights for 18¾ hours required the consumption in the pots, by oxidation, of about 8 pounds of carbon. The average pressure during the test from the 100 cells was 90 volts, and the current 16 amperes. Messrs. Stone & Webster report that the electrical energy actually obtained from the carbon consumed in the pots was 82 per cent. of the theoretical.

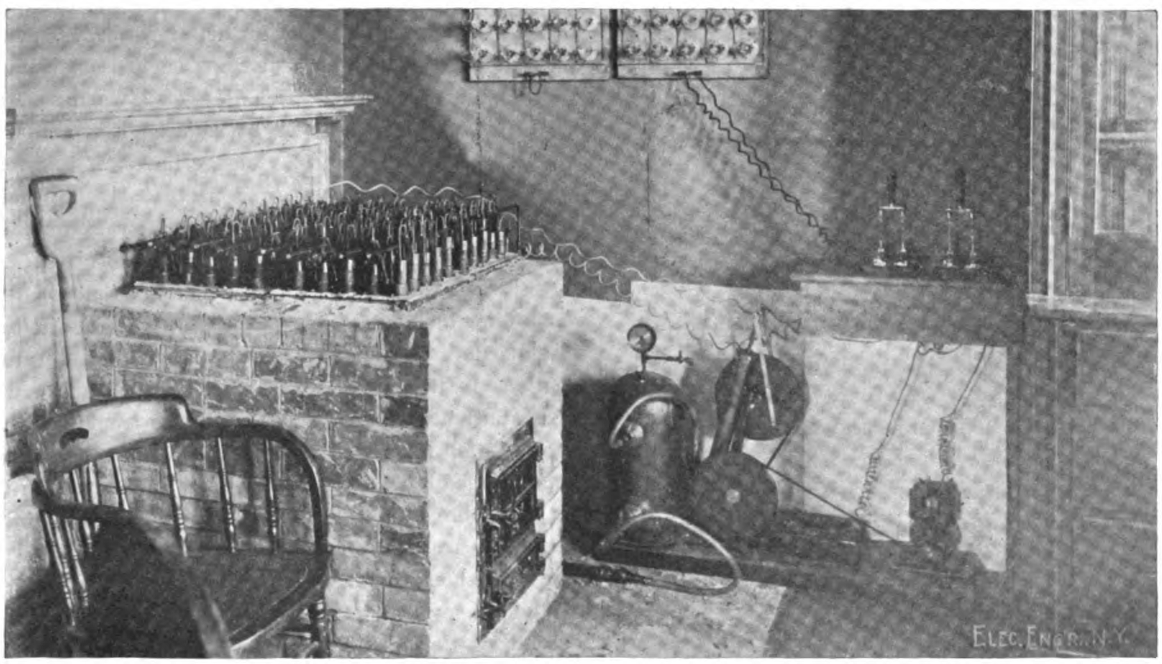

FIG. 2.—THE JACQUES CARBON CONSUMING PRIMARY BATTERY.—VIEW IN DR. JACQUES' LABORATORY.

WORCESTER POLYTECHNIC INSTITUTE.

The above Institute, of which Dr. T. C. Mendenhall is now president, has just issued its annual prospectus and catalogue for 1896. As a pioneer technical school, Worcester has kept well in the van, and to-day its personnel and equipment make it a very attractive place for technical studies in the broad engineering field. Students who aim at rounded work in the various branches of mechanics, civil engineering, electricity and chemistry, are likely to find at Worcester their opportunity for the best training in physical science and application.

FRESNO CITY PUMPS RUN BY ELECTRIC POWER TRANSMITTED 35 MILES.

The pumps at the city water works were run by electricity for the first time on April 14. The new company, which is bringing the power from the San Joaquin River, thirty-five miles distant, has turned on the current. A test was made several days ago with the lights, and since then additional machinery has been put in, and a 75 horse-power pump was run as smoothly as if it weighed but a few pounds.

ELECTRIC MOTOCYCLES are proposed for the park at Lake Harriet, Minneapolis. The idea is to run large carriages, capable of carrying twelve persons each. A floating race track for bicycles, lighted electrically, is also proposed.

THE WILLIAMSPORT WOODEN PIPE CO. have an exhibit of their creosoted wooden conduit, steam pipe casing and crooss arms, at the Exposition.

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CONTENTS.

A GREAT EXPOSITION.

The exposition now being made at the Grand Central Palace, in this city, by the National Electrical Exposition Company, under the auspices of the National Electric Light Association, is already a pronounced and emphatic success. A localized show which attracts about 50,000 people in its first week, when many of its features of interest have not been brought into action, has evidently many considerable merits. As a matter of fact, while other electrical expositions may have excelled it in one element or another, in its general average of excellence and artistic setting, this is conceded to take the palm. At Philadelphia, in 1884, electric lighting dominated, as at Paris earlier. At the World's Fair the generating plant was practically all located outside the Electricity Building, and that place was one of the dullest, as to moving machinery, in the whole great show, and never other than chilly in its aspect. At the Grand Central Palace the general aspect is wonderfully brilliant and warm in its coloring, while the generating plant is all in the big basement, down one flight of stairs. Compactness counts for a good deal when there are large numbers of exhibits to look at, and fortunately at the Palace condensation has been the "mot du jour." Nobody has gone in for hugeness, and yet there is the cream of the most modern products in electricity, as well as a historical collection that is hardly likely to be duplicated in this country.

The features of interest in this choice show are so numerous it is difficult to particularize. The generating plant, however, with its battery of boilers of some 600 horse-power, run by a pretty woman, and its string of some fifteen different direct connected units of engine and dynamo, is certainly worthy of the attention of every steam and electrical engineer. "Direct connection" has never before made so emphatic a demonstration in this country of its quality and possibilities, and while there is still abundant room for better work, it is evident that the "unit" type has won a place as a very useful advance in the art of current generation. Next as worthy of attention come the varied applications of motor power, and with these might be ranked the display of arc lamps of latest form, especially for multiple work, and particularly the inclosed arc style. The latest results with this, widely exemplified at the show, are most pleasing and satisfactory.

Every electrical engineer will find his time well spent in examining the remarkable collection from the United States Patent Office of some 365 models illustrating the greatest inventions in the respective leading lines. Equally worthy of close study are the historical collections from Mr. Edison and Prof. Elihu Thomson, and the collection of incandescent lamps loaned by Mr. W. J. Hammer. And as though this were not all, there is a superb collection of experimental and research apparatus from leading schools and colleges that one can spend hours over.

We need say little of such interesting things as Mr. Edison's exhibit of the Röntgen X-ray effects, Mr. Moore's vacuum tube lighting, the Niagara Falls transmission of power and sound, the operative model of the Erie Canal electrified, etc. These will attract easily, but underlying these and as adjunct to them is a mass of solid commercial and industrial exhibits

that is a credit to the art and a splendid augury for its future prosperity.

AN INTERESTING CONVENTION.

It was feared by many that the exposition would by its interest and charm swamp the convention, but the effect was just the contrary. The meetings have rarely been so well attended, and the interest was far above the average in many ways. Mr. Wilmerding is to be congratulated upon so brilliant a close for his memorable year of office, and Mr. Nicholls upon succeeding to the presidency at a time when the association has shown itself to be so strong and vital and progressive. The choice of such high-grade men as these for the officers of the association is of itself a guarantee of good work which "betters what is done."

The discussions which nearly all the reports and papers submitted to the convention called forth were almost uniformly as interesting and valuable as these contributions themselves; indeed, the failure of a committee to report brought out one of the liveliest discussions had during the convention. We refer to the Committee on Relations Between Manufacturing and Central Station Companies. We fully agree with those members who believe that if ever there was a time when such a committee can be of use to the association it is the present. With the combination among the largest manufacturing companies now existing, the central station owner may well look forward to the future with misgivings, if he remain inert. Complaints are constantly heard on all sides of unfair treatment of central station companies that were organized under promises of protection, but which promises are now sought to be evaded by alleged inability to control the action of individual members of the "combine." But we believe that these matters can be remedied and that if a vigorous and aggressive policy were adopted by the National Electric Light Association the manufacturing combination would be compelled in sheer self-defence to alter its present obnoxious methods. Mr. Beggs has well said that 2,700 central stations ought to be powerful enough to compel respectful consideration. He might have gone further and added that in default of such consideration these central stations themselves might combine and do their own manufacturing on a coöperative basis. It is on open secret that such a plan has been considered in several quarters by companies taking a considerable percentage of the output of the combination's factories. We trust that for the good of all concerned such a step may not become necessary, nor will it, if the association makes the best of its opportunities; but that some action, and that of the most vigorous kind, will be necessary to prevent it, is open to little doubt.

A notable feature of the proceedings was the almost total absence of all reference to the incandescent lamp. Whether this be due to the fact that there is little to be said on the subjct or that central station managers are now more actively engaged in pushing arc lighting on their constant potential systems, the fact remains that the arc lamp practically obsorbed all the attention given to lighting. Mr. Rogers' paper certainly put the subject in a strong light, and some of the home truths embodied in his paper can hardly be called flattering to the arc lamp-makers of the past twenty years. The recent marked improvement, both in the construction of arc lamps and in the adoption of the inclosed arc, has certainly served to place the arc lamp a long way ahead in the scale of usefulness; and, if any doubts on this subject still exist in the minds of electric light purveyors, a visit to the electrical expostion must soon dispel it. It is now only a question of a short time when the enclosed arc will be adapted to series lighting circuits, and when the day of the double carbon lamp will be at an end. It will not be greatly missed, nor will its memory call forth pleasant recollections. It will have served its purpose, and, like many other very useful devices in the modern electric arts, may find a last resting place in the scrap heap and in historical collections.

Power distribution by alternating current, judging from the discussions of Mr. Emmet's and Mr. Leonard's paper, is still one of the uppermost questions of the day in central station circles. The flexibility of the modern polyphase system, so well shown in Mr. Emmet's paper in undeniable, and the really remarkable output of such apparatus placed by one company within the past three years is worthy of all praise. But it was evident throughout the discussion that what most of the members present were longing for was a motor that could be operated satisfactorily on their present single-phase circuits. It seems strange, indeed, that with all the talent and experimental facilities at their disposal, the large manufacturing concerns in the country have thus far failed to produce such a machine. We are glad, therefore, to note the recent progress alluded to in Mr. Leonard's paper, and the work now being done in other directions looking to the same end.

THE INFANT.

If there is one thing more than another that tires the plain electrical man, it is to be told that his field of work is chiefly characterized by its juvenility. Some remarks he can stand, but that always upsets his equanimity, and he does not need to have read through Dr. Park. Benjamin's fine collection of early electrical literature to justify him with evidence to the contrary and warrant for his protest. Scientifically considered, the art is very old, and when it comes to industrial statistics, it is certain that electricity has plenty to produce. Just at this juncture, when the public is talking electricity "for all it is worth," it may not be out of place to present a few familiar but concrete facts showing what electricity has actually done. For example, in the United States to-day there are 65,000,000 telegrams sent every year. The telephone exchanges of the country take care of 750,000,000 telephonic conversations every year. There are 2,700 central electric lighting stations in the country, and some 7,000 isolated plants. There are not less than 15,000,000 to 20,000,000 incandescent lamps burning in this country, and the number of arc lamps reaches toward a million. Nobody knows exactly how many motors have gone into use, but if we include fan motors, the figure must certainly touch 500,000. The trolley roads of the country reach 1,000, with 12,000 miles of track and 25,000 cars. The investment in mining plants is estimated to have reached $100,000,000, and in electrical power transmission $50,000,000. All told, the capital represented in the various electrical industries to-day is fully up to $1,500,000,000, all fairly well earning in the main, and much of it handsomely. At least 2,500,000 people in the United States are directly or closely dependent upon electricity for their livelihood and sustenance.

NINETEENTH CONVENTION OF THE N. E. L. A.

MAY 5.—MORNING SESSION.

THE nineteenth convention of the National Electric Light Association was held at the Grand Central Palace, New York City, May 5-7, 1896. President C. H. Wilmerding, of Chicago, presided, and Secretary George F. Porter was in his customary place. On the platform were Vice-Presidents James I. Ayer, Edward A. Armstrong and M. J. Francisco.

After welcoming the members the president delivered the following address:

The president then declared the convention open for the transaction of business, and called upon the various committees for their reports.

Chairman De Camp, of the Committee on Relations between Manufacturing and Central Station Companies, stated that the committee had no report to make, and asked for its discharge on the ground that there was nothing for it to do. This brought about a lively discussion. Mr. Beggs believed that there was a great deal which the committee might accomplish for the good of the association; indeed, he considered it one of the most important features for which the association was organized. In fact, at this very time when combinations were being made among the manufacturing companies, it was more than ever of vital importance that the operating companies whose purchases amounted to hundreds of thousands of dollars annually should be closely banded together for their own protection.

Judge Armstrong, with fine sarcasm, indorsed Mr. Beggs' views on the necessity of such a committee, and instanced a case in his own experience in which his company had been oppressed by a large manufacturing company, "the magnificent and a large one, the General one," and, after two years' waiting for an "adjustment" of the matters complained of, was still waiting. He took issue, however, with Mr. Beggs on a point made by that gentleman, that the association was of no benefit to its members. On the contrary, Judge Armstrong declared that he had always benefited by his attendance at the conventions and by rubbing up against others in the business and profession.

Mr. De Camp, in extenuation of the absence of a report, stated that when the committee was organized it was expected that those who had grievances would make them known to the committee, but no one had ever brought any such matters to the attention of the committee. Mr. Beggs expressed the opinion that Mr. De Camp had formed an entirely erroneous conception of the objects of the committee, which were of a general character, and not intended to take cognizance of specific cases alone. He instanced a case in which a similar committee of another organization had obtained relief for grievances from a large manufacturing company within thirty days after the organization of the committee. His idea of what a committee of this kind would be was to take up the broad question of the honesty and fairness of the manufacturing and parent companies throughout the country in going into territory simply for the purpose of exploiting apparatus and of wrecking capital. He was there to say that if this organization of central station men from all parts of the country would take hold of the matter actively, Mr. Francisco would not be compelled to sell arc lights at $2.33 per month to burn until 12 o'clock every night in the year, simply because some company owned by these parent companies sought to obtain franchises, and to which company the manufacturing companies desired to sell a new outfit in that city. This was not an exceptional case, by any means. The results, possibly, were more disastrous than in other cases, but he saw sitting there a number of gentlemen who were laboring under similar conditions today. That was his idea of what a strong, aggressive committee should be to deal with the general question between the central station people who composed the N. E. L. A. and the various State organizations that were springing up now and the general manufacturers. I tell, you, gentlemen, said Mr. Beggs, that you to-day represent possibly a hundredfold the amount of capital that is represented by these large new-order manufacturing and parent companies. I will withdraw my opposition to the disbanding of this committee, if it was formed by the purpose as stated by Mr. De Camp, because I do not see any force in that, but I believe that a committee should be appointed and continued, and held accountable to make a report to this organization, and that report to mean something. I certainly think that it is a very great necessity.

Judge Armstrong stated that to avoid misunderstanding his motives, he was not only willing, but anxious that some committee should be appointed to carry out all that Mr. Beggs desired, and that the most drastic measures should be resorted to in furthering the objects for which the committee was appointed.

The motion to discharge the committee was carried, and the meeting adjourned to 3 p. m.

MAY 5.—AFTERNOON SESSION.

The President opened the session by reading letters from Mr. Tesla, wishing success to the convention, and from Mr. T. D. Lockwood, an honorary member of the association, expressing the hope that he would be able to attend the latter part of the sessions. An invitation was also extended to the members to visit the roof of the American Surety Building; also one from Mr. R. R. Bowker, for the members to inspect the new stations of the New York Edison Electric Illuminating Company, and from the Crocker-Wheeler Electric Company to visit the company's works at Ampere, N. J.

Mr. L. A. Ferguson then read a paper entitled "Acetylene Gas."[1]

In the discussion which followed, Mr. F. Nicholls stated that from his experience he did not believe it would be safe to ship carbide of calcium in barrels. He knew the slightest moisture seemed to affect it, and in much the same manner as lime is affected by moisture. One drop of moisture on acetylene causes the gas to generate quickly; and if that came in contact with a flame, with a lighted match, or anything of that kind, in case it were alongside of a freight car, for instance, he thought it might prove disastrous. He had had no practical experience in the matter, other than having seen the effect of it in that way; he inquired of Mr. Ferguson if he had examined it in that aspect of the case.

Mr. Ferguson did not think anybody had had any experience in the actual shipment of carbide of calcium, but he had no doubt Mr. Nicholls was quite right in his assumption. The estimate he had made in his paper was probably very low as to the cost of barrels and the cost of shipment, but as it was such a small item, he thought he would put it on that basis, which would cover the cost of ordinary barrels of sufficient strength to contain calcium carbide; whereas, in all probability, in actual practice, one would have to use hermetically sealed tins or irons of some kind.

Mr. Beggs said that Mr. Ferguson's paper was the most exhaustive which he had ever yet seen on the subject, and moved that it be printed at once and circulated among the members of the association. Carried unanimously.

Mr. F. H. Leonard then read his paper on "Single-Phase, Self-Starting Synchronous Motors."[2]

Mr. H. A. Wagner inquired as to the effect of switching at the central station on the operation of the motor when running at full load. He had had such motors in operation covering a period of three years, and found that it was an almost insurmountable objection to the use of the synchronous motor, as the frequent switching found necessary to properly divide the load on alternating current generators caused the motors to fall out of stop.

Mr. Leonard replied that what Mr. Wagner said was quite true. If a motor fully loaded has the current switched off, it will slow down to a point so much below synchronism that it is impossible to go on, unless the switch is reversed so as to put it in the position of starting. In most stations where these motors have been used, the circuits on which the motors are run are not switched, except at hours when the motors are not in service, or it is done while the machines are in multiple, preventing the breaking of the circuit and the cutting off of the current. Mr. Van Trump inquired if there was not some difficulty in operating these motors due to a difference in the curve; that is, in the wave-line of the motor differing from that of the generator. He had met with such trouble in practice with synchronous motors. Mr. Leonard replied that these motors were wound, as stated in his paper, with a concentrated, that is, an ironclad winding. The wave-line made no difference.

Mr. Ferguson inquired whether, in case the machine was started up on a light load, and the operator did not fix the switch in time to allow the machine to accelerate its speed, it would not go all to pieces. Mr. Leonard replied that such would be the case, but explicit instructions to avoid this accompanied each machine, and if an attendant allowed it to happen once he never did it again. (Laughter.)

Mr. Wagner again referred to the difficulty in the operation of synchronous motors due to the switching at the station, and that while this would not occur in alternating stations in which machines were coupled in multiple, unfortunately very few, if any, stations were so operated at the present time. Mr. Leonard stated that in practice very little difficulty had been encountered on that score. It seemed to him that it could readily be arranged so that feeders supplying the motor power could be handled in such a manner that it would be unnecessary to switch very much during motor-load hours. In any

[1] See page 489.

[2] See page 491.

event, it was but a matter of a few seconds to start the motor up again, and as there was a great demand for such a motor, people were willing to put up with a slight objection, and to adjust the conditions so as to avoid the difficulty.

Mr. Wagner stated that he did not make his criticisms as reflecting at all upon Mr. Leonard's motor, but merely from the fact that he had had motors of exactly the same type in operation for the last three years, and had finally decided that he would have to give up work on that line, as such objections seemed to be insurmountable in ordinary practice. He admitted that he failed to solve the problem himself.

Mr. A. Churchward then read his paper on "Equalizer Systems of Distribution."[1]

Mr. C. L. Edgar, in the discussion which followed, declared that these systems in general all had one weakness, depending upon one inherent difficulty; every one of them, as he understood it, would go to pieces if the neutral wire came in contact with the outside wire; all the lamps on the outside would burst. Mr. Churchward denied this action. Mr. Edgar stated that he had tried the same experiment three or four years ago, but got into the trouble mentioned. Mr. Churchward said that the same point was made when he started out, but he had been looking for it in vain ever since. He did not claim any economy for the system, but advocated it merely as a method of getting around the three-wire system.

Upon motion the convention went into executive session, and then immediately adjourned the executive session until after the close of the next morning's meeting.

MAY 6.—MORNING SESSION.

The president called the meeting to order at 10:30, and announced as the first business the reading of the paper by Mr. W. L. R. Emmet, on "Results Accomplished in Distribution of Light and Power by Alternating Currents."[2]

A lively discussion followed which occupied the rest of the session, and which was participated in by Messrs. Wagner, Emmet, Ayer, Scott, Van Trump, De Camp and others. Owing to our crowded condition we are compelled to postpone the report of this interesting discussion until next week.

Before adjournment a letter was read from Prof. Elihu Thomson, regretting his inability to be present at the meeting. Adjourned to 2 p. m.

MAY 6.—AFTERNOON SESSION.

Vice-President Nicholls called the convention to order.

Judge Armstrong read a paper on "Evolution of Interior Conduits from the Electrical Standpoint,"[3] by Luther Stieringer. In the absence of the author the discussion was postponed, and a vote of thanks passed for Mr. Stieringer's able paper.

Mr. John A. Kelly then read a paper on "The Evolution of the Inductor Alternator."

Dr. Louis Bell characterized Mr. Kelly's paper as a peculiarly effective résumé of the work that had been done on this very simple machine. Perhaps the reference in Mr. Kelly's paper which most interested him was that relating to the sine-wave controversy. It has been pointed out by some investigators that the distorted wave is capable of giving better results with static transformers, slightly better efficiency, than a sine-wave of the same frequency. The effect on the transformer is very closely similar to that which would be obtained by taking an alternator that gives a true sine-wave and slightly raises the frequency. With inductor motors nearly all experimenters seem agreed that what difference there is between the alternators having a sine-wave and those that have not a sine-wave, is in favor of the former.

The report of the Committee on Rules for Safe Wiring[4] was then read by Mr. W. J. Hammer.

Mr. Seeley moved that the committee's report be received and spread upon the minutes, and a vote of thanks extended to them for their arduous labors, and that the committee be discharged. Motion was carried.

A long discussion ensued, which was taken part in by Messrs. Armstrong, Hammer, Ayer, Brophy and others, and ended in Judge Armstrong offering the following resolution:

Resolved, That a committee of five be appointed by the President on Standard Electrical Rules, which committee may designate some one to confer with the representatives of other bodies on the same subject, with power to expend not exceeding $25 annually. The resolution was carried.

Mr. Ayer offered the following resolution:

Resolved, That a committee be appointed by the president to confer with a similar committee of the Amer. Inst. of Electrical Engineers to effect a standard of candle-power for incandescent lamps. The resolution was carried.

In answer to the question of a member, whether the electric light companies could be classed as manufacturing companies under the statutes, Mr. De Camp stated that the Pennsylvania State Supreme Court had decided that such companies were not manufacturing companies. Another member stated that this matter had been brought before the Gas and Electric Light Commission in Massachusetts, and their decisions were that electric light companies were manufacturing corporations. Whether the courts had backed that up or not, he did not know.

The convention then went into executive session.

MAY 7.—MORNING SESSION.

The President called the meeting to order at 10:35 o'clock, and appointed the following gentlemen a Committee on Nominations: Messrs. Armstrong, Leslie, Francisco, Giles and Huntley.

A communication was read from John Caird, Principal and Vice-Chancellor of the University of Glasgow, and Sir James Bell, Bart., Lord Provost of Glasgow, inviting the Association to send a representative to the Lord Kelvin Jubilee next month. President Wilmerding appointed Mr. T. Commerford Martin to represent the Association. The appointment was ratified and Mr. Martin was instructed to prepare and to present to Lord Kelvin a set of resolutions on behalf of the Association.

Mr. Seely as chairman of the Finance Committee made the following report, showing financial transactions during the year as follows:

Receipts	$6,485.41
Expenses	5,746.76
Balance	$736.65

The assets of the Association are $1,792.94; active members, 111; associate members, 90.

A lengthy discussion ensued as to the time which should be included in the report of the Finance Committee; the report made having been brought down to the first of January, 1896. It was decided, as the result of the discussion, that the report should be made to include all financial matters up to within thirty days of the meeting.

A letter from Mr. Edward H. Johnson, of the Interior Conduit and Insulation Company, was read inviting the delegates to witness a demonstration of a new system of surface contact for street railways in the Exhibition Hall.

The president made the following gentlemen a Committee to confer with the American Institute of Electrical Engineers for the purpose of Determining a Standard Candle Power for Incandescent Lamps: Louis Bell, chairman, James I. Ayer and Louis A. Ferguson.

The president appointed William Brophy, chairman; C. B. Barnes, William J. Hammer, James I. Ayer and Mr. C. L. Edgar a Committee of five on Standard Electrical Rules; which committee may designate some one to confer with the representatives of other bodies on the same subject; with power to expend not exceeding $25 annually.

The report of the Committee on Data was then presented.

Mr. Swetland asked for the discharge of the committee, as in its present form the results of the committee did not pay for the time spent on the work. Judge Armstrong and Mr. Beggs advocated the continuance of the committee's work but limiting it to the statistics of a number of standard stations of different types. The following resolutions were offered by Judge Armstrong:

Resolved, That the Executive Committee be directed to expend such an amount of money as may be necessary to procure data from representative companies for the benefit of the committee. Carried.

A letter from the United Electric Light and Power Company was read, inviting the delegates to visit the new central station of the company at the foot of East 28th street, New York City.

Mr. Alfred Swan was down on the programme to open the discussion on "A Standard Socket." He was not able to be present, and submitted a communication on the subject.

The paper by Mr. H. L. Rogers on "The Evolution of the Arc Lamp," was read.[1]

The paper was listened to very attentively, and created much humor at times. Judge Armstrong said that he had heard some modest man behind him say that this was the cheeriest and most interesting paper that had ever been heard at one of these conventions. He felt that the good suggested which might come from the paper was something that merited the heartiest thanks, not only of the electric light men, but the never dying, ever present, ever active individual referred to in the paper—the taxpayer. The motion of thanks was carried.

The President then called on Captain Brophy, who made a short address on "Electrolysis," in which he traced the history of this evil and the remedies to be applied to avoid it.

The meeting then adjourned to 2.30 p. m.

1) See page 481. 2) See page 482.
3) See page 486. 4) See page 494.

1) See page 492.

MAY 7.—AFTERNOON SESSION.

The first business was the reading of the paper by Mr. Albert A. Carey, on "Steam Boilers; their Equipment and Management." Mr. Carey illustrated his paper with drawings on the blackboard.

The convention then went into executive session.

Mr. Seely, as chairman of the Finance Committee, made a supplemental report, in which he stated that the total cash on hand in the treasury of the association at the present time was about $5,000.

The following resolution was passed:

Resolved, That the Executive Committee be instructed to require that all papers to be read before the convention be first submitted for their approval, and if approved, that such papers shall be printed and placed in the hands of the members at least one week before the meeting, when such papers shall not be read in full, except by special order, that the time occupied in reading such papers may be devoted to the discussion of said papers.

The Nominating Committee presented the following names for officers of the association for the ensuing year:

President, Frederic Nicholls, Toronto, Canada.

First Vice-President, Henry Clay, Philadelphia, Pa.

Second Vice-President, J. J. Burleigh, Camden, N. J.

Members of the Executive Committee for three conventions, A. J. De Camp, Philadelphia, Pa.; John A. Seely, New York City; A. M. Young, Waterbury, Conn.; H. A. Wagner, St. Louis, Mo., to fill the vacancy caused by the election of Mr. Nicholls to be president.

Mr. Wilmerding, the retiring president, expressed his gratification at the manner in which the convention had passed off, and thanked the members for their assistance in contributing to its success. On motion of Mr. Seely, the secretary was instructed to prepare a set of resolutions to the retiring president for the manner in which he presided over the meeting. Mr. Nicholls, the newly-elected president put the motion, which was carried, and the meeting then adjourned sine die.

We give below a list of the names of the out-of-town attendants at the convention. To give a full list of the New Yorkers present is a sheer impossibility. Everybody was there.

ADAMS, N. Y.—W. L. Pratt.
ATLANTA, GA.—N. Y. Edgar.
BALTIMORE, MD.—J. W. Ellard.
BANGOR, ME.—J. N. V. Lane and W. E. Pierce.
BINGHAMTON, N. Y.—S. D. Cushing.
BRATTLEBORO, VT.—F. Taft.
BRISTOL, PA.—Charles E. Scott and Benjamin J. Taylor.
BRYAN, O.—W. A. Sheldon.
BOSTON, MASS.—H. L. Albright, C. C. Allen, G. M. Angier, James I. Ayer, M. H. Barker, W. S. Barker, C. E. Bibber, James Bradley, H. H. Brooks, Capt. William Brophy, J. F. Bubert, C. B. Burleigh, A. R. Bush, Arthur E. Childs, A. T. Clark, J. Comelliard, S. B. Condit, Henry B. Cram, B. W. Cutter, H. M. Daggett, Jr., Geo. W. Davenport, C. B. Davis, D. W. Dunn, C. L. Edgar, P. Fahey, W. J. Ferris, T. W. Flood, F. A. Gilbert, H. F. Golsin, C. E. Gregory, C. S. Haley, J. Y. Hamby, H. C. Hawks, W. P. Hill, W. S. Hill, C. W. Holtzer, Sidney Hosmer, A. L. Ives, A. B. Jenks, F. M. Kimball, G. A. Lancaster, E. C. Lewis,, T. D. Lockwood, Norman Marshall, J. H. Mason, J. M. Orford, Sidney B. Paine, H. C. Patterson, C. B. Price, C. J. Reilly, P. M. Reynolds, Frank Ridlon, R. F. Ross, T. C. Sias, F. B. Smith, H. C. Spaulding, F. B. Sweet, Calvert Townley, Donald F. Urquhart, G. W. Ward, C. A. White, James Wolff, F. B. Witherbee, C. J. H. Woodbury and A. Arthur Ziegler.
BUFFALO, N. Y.—C. R. Huntley, G. Urban, Jr., and W. Wentworth.
CANANDAIGUA, N. Y.—C. J. Purdy.
CANAJOHARIE, N. Y.—C. S. Fargo.
CARBONDALE, PA.—J. W. C. Aitken.
CHARLOTTE, N. C.—H. Thompson.
CHELSEA, MASS.—E. A. Chapel, George W. Moses and W. G. Peck.
COLORADO SPRINGS, COLO.—E. E. Wade.
COLUMBUS, O.—A. W. Field and Adolf Theobald.
CONCORD, N. H.—George B. Lander.
CUYAHOGA FALLS, O.—C. L. Babcock.
CAMDEN, N. J.—E. A. Armstrong, C. C. Burleigh and J. J. Burleigh.
CHICAGO, ILL.—Forée Bain, W. F. Collins, Henry Cribben, W. J. Ferris, J. Holt Gates, C. E. Gregory, H. K. Golsin, R. J. Randolph, C. J. Reilly, J. R. Wiley, C. H. Wilmerding and James Wolff.
CINCINNATI, O.—John I. Beggs, W. L. Bradshaw, J. A. Cabot, Thos. J. Creaghead, J. S. Nowotny and W. M. Venable.
CLEVELAND, O.—V. Browning, W. B. Cleveland, H. J. Dowds, M. M. Hayden, G. M. Hoag, S. K. Johns, S. C. D. Johns, B. T. Miles, L. H. Rogers, W. S. Rogers, Charles W. Wason and Bailey Whipple.
HARTFORD, CONN.—C. E. Dustin, G. W. Hart, E. B. Hatch, C. E. Newton and A. H. Pease.
MILWAUKEE, WIS.—J. Goldschmidt, W. F. Hyde, J. R. Mercein and A. Smith.
MONTREAL, CAN.—Prof. H. T. Bovey, W. H. Browne, F. R. Redpath, R. A. Ross and G. W. Sadler.
NEW BEDFORD, MASS.—C. S. Mendell, Charles R. Price, George R. Stetson and A. P. Smith.
PHILADELPHIA, PA.—James G. Biddle, C. A. Bragg, C. M. Corpening, J. T. Cowling, H. B. Cutter, F. W. Darlington, A. J. De Camp, W. E. Harrington, George W. G. Holman, A. H. James, W. O. Knudson, C. W. Dazar, H. J. Manloux, A. H. Manwaring, John Mustard, S. L. Nicholson, A. B. Poulson, O. D. Pierce, J. P. Richardson, Charles J. Russell, T. Carpenter Smith, E. Ward Wilkins, C. M. Wilkins, E. T. Wilkinson and E. G. Willyoung.
PITTSBURG, PA.—B. H. Blood, J. S. Crider, E. H. Heinrichs, A. H. Mustard, Robert J. McGoumel, J. W. Marsh, C. F. Scott and H. E. Webb.
PITTSFIELD, MASS.—J. H. Finley, W. R. Gardener, Henry Hine and J. F. Kelly.
PROVIDENCE, R. I.—J. F. Blauvelt, Eugene F. Phillips, Frank N. Phillips and C. R. Remington.
ROCHESTER, N. Y.—Charles F. Barnes, Fred. Fish, F. Kirk Knowlton, J. A. Olmstead, J. E. Putnam and George A. Redman.
SCHENECTADY, N. Y.—J. P. Feeton, S. D. Greene, J. R. Lovejoy, E. W. Rice and C. P. Steinmetz.
ST. LOUIS, MO.—E. H. ABADIE, Edwin S. Pillsbury, J. H. Rhotehamel, E. G. Spencer, J. A. J. Shultz, H. A. Wagner and Sylvester Watts.
UTICA, N. Y.—W. C. Ballda, William F. Bossert, W. E. Lewis, J. F. Mann, D. McAfee, T. R. Proctor and H. P. Roberts.
WASHINGTON, D. C.—H. G. Balkam, P. A. Draper, J. Kennedy, F. D. Royce, F. W. Royce and A. A. Thomas.
WORCESTER, MASS.—Charles W. Bassett, John P. Coghlin, W. H. Coughlin and H. H. Fairbanks.
DAYTON, O.—H. W. Fullerton.
DERBY, CONN.—R. E. Nugent.
DETROIT, MICH.—C. H. Matthews, C. A. Ducharme and Alex. Dow.
EASTON, PA.—E. C. Hillyer.
ELIZABETH, N. J.—E. N. Stevens.
FALL RIVER, MASS.—G. W. Palmer.
FOSTORIA, O.—J. B. Crouse and H. A. Tremaine.
FITCHBURG, MASS.—H. F. Coggeshall and A. H. Kimball.
FREDERICK, MD.—Dudley Page and Arthur L. Bosley.
GERMANTOWN, PA.—Charles M. Allen.
HAMILTON, O.—Felix Kuhn.
HARRISON, N. J.—E. J. McAllister.
HAVERHILL, MASS.—S. B. Libby.
HAZELTON, PA.—A. Markle.
HOLYOKE, MASS.—S. B. Winchester.
HORNELLSVILLE, N. Y.—L. T. Mason.
HOUGHTON, MICH.—James A. Dee, Lessing Karger and Irving J. Sturgis.
ITHACA, N. Y.—Edward L. Nichols.
KEARNEY, NEB.—George W. Frank, Jr.
LANSING, MICH.—Philip B. Woodworth.
LOCKPORT, N. Y.—F. E. Ellsworth and I. H. Babcock.
LITTLE ROCK, ARK.—E. V. Fish.
LONDON, ONT.—Charles D. Hunt.
LOWELL, MASS.—L. A. Derby and J. Arthur Gage.
MARION, IND.—R. E. Lucas.
MASSILLON, O.—J. W. Fisher.
MANCHESTER, N. H.—E. M. Bryant, Albert Merrill and J. Brodie Smith.
MECHANICVILLE, N. Y.—H. J. Medbery.
MEMPHIS, TENN.—S. T. Carnes.
MERIDEN, CONN.—Herman Nimkwitz.
MARLBOROUGH, MASS.—H. Bottomly.
NASHUA, N. H.—George L. Sadler.
NEWARK, N. J.—F. F. Gardiner, C. McIntire and Edward Weston.
NEW BRITAIN, CONN.—T. H. Brady and Robert S. Brown.
NEW BRUNSWICK, N. J.—A. J. Jones.
NEWTON CENTRE, MASS.—Dr. Louis Bell.
NEWTON, MASS.—Waldo A. Learned and W. E. Holmes.
NORFOLK, VA.—James L. Belate and W. W. Chamberlain.
OGDENSBURG, N. Y.—J. H. Findley, George Hall and W. L. Proctor.
OLEAN, N. Y.—George Fobbs and Welles E. Holmes.
PEABODY, MASS.—P. L. Winchester.
PANA, ILL.—H. Hadley.
PAWTUCKET, R. I.—D. W. Dunn.
PERU, IND.—J. H. Bouslog.
POTTSVILLE, PA.—Thomas W. Haldeman.
QUINCY, ILL.—J. W. Emery, C. A. Castle and D. McAfee.
ROCKLAND, ME.—T. Hawkes and George E. Macomber.
RUTLAND, VT.—J. H. Francisco and M. J. Francisco.
SANDUSKY, O.—J. S. Speer.
SEWICKLEY, PA.—E. P. Young and J. M. Uptegraaf.
SALEM, O.—D. C. Davis.
SOMERVILLE, MASS.—T. Ellwood Smith.
SHAWNEE, O.—P. B. Verity.
SPRINGFIELD, MASS.—J. E. Madison and H. S. Anderson.
ST. JOSEPH, MICH.—W. W. Bean.
STOWE, VT.—F. M. Pike.
SYRACUSE, N. Y.—W. H. Garvin and H. J. York.
TERRE HAUTE, IND.—B. St. John Hoyt.
TORONTO, CAN.—Frederic Nicholls.
TROY, N. Y.—E. G. Bernard.
UNIONTOWN, PA.—J. Seaman.
VINCENNES, IND.—H. W. Frund.
WATERBURY, CONN.—A. M. Young and A. O. Shepardson.
WAUWATOSA, WIS.—T. F. Grover.
WEST SUMMERVILLE, MASS.—F. E. Smith.
WINDSOR, CONN.—A. D. Newton and M. E. Baird.
WILKINSBURG, PA.—John J. Jennings.
WESTCHESTER, PA.—James E. Pyle.
WEST MEDFORD, MASS.—W. E. Ober.
WILMINGTON, DEL.—C. R. Van Trump.
WOBURN, MASS.—G. A. Blaisdell.
WALTHAM, MASS.—F. H. Hill.
WARREN, O.—W. D. Packard.
WATERTOWN, N. Y.— R. E. Cahill.

NOTABILITIES AT THE EXPOSITION.

There can be no question of the fact that the Electrical Exposition has "caught the town." Fashionable visitors are there in throngs, and notabilities can be counted by the dozen every night. Among those present last week were George Westinghouse, Jr., T. A. Edison, Cornelius Vanderbilt, Chauncey M. Depew, Charles Delmonico. The meeting between Prof. Bell and Mr. Edison was very interesting, and took place in the private reception room fitted up for the fluoroscope exhibit. Prof. Bell was escorted through the Exposition by Mr. Herbert Laws Webb, and took much pleasure in listening to the roar of Niagara at the Niagara model. The pair of receivers used by him were immediately labeled and put within the model case.

THE INCLOSED ARC is emphatically one of the most noteworthy features of the exposition. It burns everywhere with brilliant success and silence.

THE CROCKER-WHEELER ELECTRIC CO.'S "AT HOME."

MAY 7 will long be remembered as a red letter day in the history of Ampere, N. J. On the evening of that day no less than 4,000 visitors, who came by train, boat, bicycle and on foot, invaded the usually quiet village for the special purpose of inspecting the new works of the Crocker-Wheeler Electric Company, and they were well rewarded for their trouble. The two regular trains from New York brought about 200 and 400 people, respectively, and the special train in charge of Dr. Wheeler and Superintendent Griffith, of the works, which arived at 8:45, brought 580 visitors from New York in ten cars. The crush was so great, indeed, that it was necessary to hold the Christopher street ferryboat some minutes in order to let the party pass through the gates.

There was no mistaking the place by the stranger, for a huge sign "Ampere," in incandescent lamps, with letters six feet high, blazed forth on the lawn facing the station. One hundred steps brought the visitor into the works, where Messrs. Crocker, Wheeler, Dunn, Jeffrey, Lufkin, and their assistants, welcomed the guests.

Thousands of incandescent lamps illuminated the great works, in which every machine tool was at work producing a particular part of the dynamos and motors, which are the specialties of the company. Beginning at one end of the building, which is 550 feet long, the visitors saw the punching machines and shears at work cutting out the special shapes of armature plates. When put together and mounted on their spiders and shafts they are passed along the shops to receive the wires; joining their frames and field magnets a little farther along the dynamo takes its complete shape at the testing department, after which it is boxed and ready for forwarding by a branch of the Delaware, Lackawanna and Western Railroad, whose tracks enter the building.

The principal engineering feature of these works is the employment of the electrical power transmission system, each tool being operated by its own motor fixed in the frame or attached to the bedplates, thereby economizing power to an enormous extent and also giving greater liberty in arranging the position of tools, as they are independent of locality. This latter feature was illustrated in a striking manner by one of the large lathes weighing about four tons, which was slung in the traveling electric crane, and kept passing up and down the shop above the visitors' heads while it was turning a 5-inch steel shaft 10 feet long, the shaving from the tool coiling down among the guests, who broke off yards of it as souvenirs. The cut which was being taken by this tool was half an inch deep.

The result of the electric power system is that all power used in connection with a machine stops when the machine is out of use, there being no long heavy lines of shafting to be kept in motion whether machines are working or not, as in the old style shops. It may not be generally known that on the average 70 per cent. of the indicated power of shop engines is absorbed by shafting without a particle of work being done by the tools. When this is compared to the loss of 10 to 12 per cent. in the motors in the electric power system the enormous advantage of the latter becomes apparent. In this connection an interesting photo was exhibited illustrating a lathe at work under a canvas tent; this photo carries with it the following legend: Thirteen months ago the company's plant was destroyed by fire and a large lathe escaped serious damage. It was moved outside the ruins at once and connected to wires, and was at work again in a few days, a tent was erected over it and it continued its work there for two months. It is estimated that if the company used shafting and belts instead of electrical power, 4,000 feet of 3½-inch steel shaft would be required for main shafting alone, with 400 pedestals, and that 125 horse-power would be required to do their work. Their average of power used for tools alone (not including lighting) is 25 horse-power, under their present system. When it is necessary to keep only a few tools at work, say at night a small donkey engine and dynamo supply the power, thereby further economizing and avoiding the loss incidental to running their main engine with the small load.

The power house is distant about 50 feet from the shop, and is a separate building connected, however, by a cable-tunnel 7 feet high and 3 feet wide, and well lighted, through which the cables are laid.

The floor of the shop is a special feature of the place, being made of cement of such a depth that no foundations are required under the machines. The heaviest machines can be placed anywhere on this floor. Ducts in which the motor wires are laid are built in the floor and radiate from the gallery pillars in which the leads are placed.

The works as a whole are perhaps the most perfect example in the country of what can be done with electric power transmission. The freedom of the shop from belts is one of the things that impress the visitor at every turn, as one naturally has to keep his eyes about him in the old style shops to avoid danger, while here there is no danger to guard against. It was a common sight to see ladies gathered around a fast moving machine on all sides with perfect safety, a thing not possible where belts are running.

At 9:45 the fire signal was given, so that the visitors might see how perfect are the precautions taken against fire. The workmen detailed for this duty left their machines at the signal, and in thirty seconds had four streams of water playing on the building. This was very quick work. The time required, however, on ordinary occasions when they are drilled, is sixty seconds.

During the evening Prof. Vorse's string orchestra of ten pieces rendered many selections in the office building, where 1,756 of the guests left their autographs in the visitors' book, the pages of which had been separated and put on different desks to facilitate the work.

The evening will long be remembered by Messrs. Crocker and Wheeler's many friends as being a most highly enjoyable and instructive occasion.

Among the guests present were the following:

Joseph T. Brown, vice-president Knickerbocker Trust Company, New York; Mr. and Mrs. H. Ward Leonard, East Orange; Mrs. Richard Arnold, Dr. and Mrs. George R. Lockwood, F. J. Griffith, superintendent Delaware, Lackawanna and Western Railroad; Miss Wilkinson, Surrogate and Mrs. John H. V. Arnold, Dr. Charles E. Emery, J. Soutter Potter, D. Walter Gibson, Prof. F. B. Crocker, of Columbia University, New York City; Mr. and Mrs. William B. Nivin, Miss Spratt, Mr. and Mrs. F. L. Eberhard, J. George Naphey, superintendent Delaware, Lackawanna and Western Railroad; J. H. Haynes, postmaster of Newark, N. J.; George D. Haynes, assistant postmaster, Newark, N. J.; F. A. Pickernell, of the American Telephone and Telegraph Company; Frederick Reckenzaun, Henry H. Holly, Jr., Mr. and Mrs. Andrew Prentiss, Dr. Charles A. Doremus, College of the City of New York, New York; W. H. Freedman, Columbia University, New York; Charles T. Rittenhouse, Chauncey Griswold, Mr. and Mrs. George R. Howe, Mr. and Mrs. A. A. Carey, New York; Prof. H. Bovey, of McGill University, Montreal, Can.; Fred F. Smith, Nelson W. Perry, J. George Hahne, Newark; John Lorillard Arden, Gramercy Park, New York; Edwin C. Alden, A. D. Baldwin, Caleb C. Green, S. C. Pullman, William Pullman, George K. Garvin, C. R. Pratt, F. M. Unstiedt, Lasavia, Jamaica, W. I.; Mr. and Mrs. Cleveland Dunn, Harris A. Dunn, Edith Fortmeyer, Judge J. Frank Fort and Miss Fort, Harding Benedict, W. T. Bowman, building inspector, East Orange, N. J.; Prof. Hovey, Irving H. Tift, Henry H. Hall, T. F. Nivin, W. Frazar Gibson, E. J. Condit, J. W. Lieb, Jr., Edison Electric Illuminating Company, New York; Dr. and Mrs. Pinkham, H. E. Shaw, Frederick E. Brown, of the New York City Board of Electrical Control; Prof. A. D. F. Hamley, Columbia University; Hon. William A. Brown, New York City; B. F. Stangland, William Jeffreys, Sr.; Stephen J. Burk, Barton Cruikshank, Mr. and the Misses Balven, Prof. W. A. Anthony, Mrs. Creagh, George F. Sever, Mr. V. Chattilon, Miss Carpenter, E. G. Snow, Reginald Arnold, N. Lester Mullen, Phillipo Torchio, Mr. and Mrs. Albert Spies and Miss Spies, L. V. Mahan, Miss Bartow, John K. Gore, Mrs. Annie P. Knowlton, D. L. Davis, C. A. Hunger, H. H. Hunger, H. R. Halsted, Abram Hyatt, J. A. Machado, Herbert W. York, engineer, United Electric Light and Power Company, New York, and Mrs. York; H. B. Walker, "German Herald," Orange, N. J.; B. J. Hamilton, Edwin J. Gillian, Thomas H. Bolmer, H. D. W. Dobbs, W. H. Ballentine, John R. Black, James Sleighter, Mr. and Mrs. E. D. Tucker, Mr. and Mrs. J. S. Hillman, Miss Hillman, C. R. Poillon, H. M. Davis, A. W. Law, Mr. and Mrs. Jos. T. Brown, Hon. and Mrs. Sydney M. Ogden, R. Varley, Jr., W. H. Demarest, Lewis C. Harker, Mrs. and Miss Colwell, Mr. and Mrs. William H. Young, R. M. Henning, Mr. and Mrs. M. H. Whiting, Mr. and Mrs. P. H. Brandt, Prof. R. Ogden Doremus, College of the City of New York; Mrs. and Miss Estelle Doremus, Maxwell M. Meyer, F. O. Runyon, the Misses Leverich, Mr. and Mrs. A. H. Palmer, George S. Hulburt, Mr. and Mrs. W. H. Force, Mr. and Mrs. W. M. Aikman, Mr. and Mrs. Mandelick, H. S. Buttenheim, H. H. Van Rensselaer, Mr. and Mrs. A. K. Sloan, Robert Christie, Jr., Miss Vanderveer, Prof. Webb, Stevens Institute of Technology, Hoboken, N. J.; C. O. Mailloux, New York; Charles Frederick Walker, Rev. M. J. Cramer, D. D.; C. Howard Parmley and wife, Frederick R. Remer, Mr. and Mrs. Ernest Napier, Miss Lillian Napier, Mr. and Mrs. C. W. Potter, Mr. A. D. Chambers, treasurer, Delaware, Lackawanna and Western Railroad, East Orange, N. J.; Alden Freeman, Albert R. Martin, Mr. and Mrs. Frank J. French, Colonel and Mrs. A. H. Ryan, J. Grant Cramer, Mr. and Mrs. F. W. Moore, Dr. J. F. McBride, W. E. Thatcher, A. C. Doane, C. F.

Herring, Mr. and Mrs. A. S. Sherwood, Mr. and Mrs. C. T. Hughes, A. Ward Brigham and son, Spencer S. Marsh, Charles Joy, Mr. and Mrs. Lincoln Righter, W. S. Robinson, M. D.; William H. Baker, William F. Poucher, William E. Ashmall, Mr. and Mrs. E. A. Spooner, William J. Campbell, M. T. Rockwell, Mr. and Mrs. Charles H. Sleight, George O. Leavitt, H. P. Backus, George Dorer, Mr. and Mrs. W. L. Merrick, Mr. and Mrs. C. A. Westervelt, A. P. Boller, G. H. Gedney, D. M. Meeker, E. R. Crippen, O. S. Young, H. R. Halsey, L. W. Woolley, E. von Diezelski, A. D. Palmer, Mr. and Mrs. Fred D. Ward, W. H. Selkirk, Samuel Bailey, J. F. Cross, S. W. Ougheltree, James Leitch, C. S. French, C. C. Jacobus, George W. Carnrick, Mr. and Mrs. Montgomery Lindsay, C. S. Stockton, George C. Miller, John Winfield Scott, Mr. Auerbacher, Ellis A. Apgar, H. D. Miller, John Remer, Lewis McCould, Edward E. Bruen, Dr. and Mrs. R. M. Sanger, Mrs. Fannie C. Jeffrey, Miss Lockwood, F. H. Kingsbury, Mr. and Mrs. William E. Davis, and H. Eber Pratt.

CONVENTION NOTES.

THE NEW YORK INSULATED WIRE CO. made things very interesting for many of the visitors to the convention, in their comfortable parlors on the first floor of the Murray Hill Hotel. There Messrs. Gallagher and Kelly, assisted ably by Mr. Wolff, of Chicago, held court for four days, and dispensed their hospitality in their usual open-handed fashion. Their parlors, in the evening especially, attracted large numbers, and a chairman for the evening being duly elected, all proceeded to enjoy life, with many a good story pertaining to the wonders of the electric fluid.

COLONEL BOOKER, of St. Louis, made his headquarters at the Imperial, and succeeded in interesting a great many in the all-important question of the best carbon to use. Dame Rumor says that "he got some orders, too."

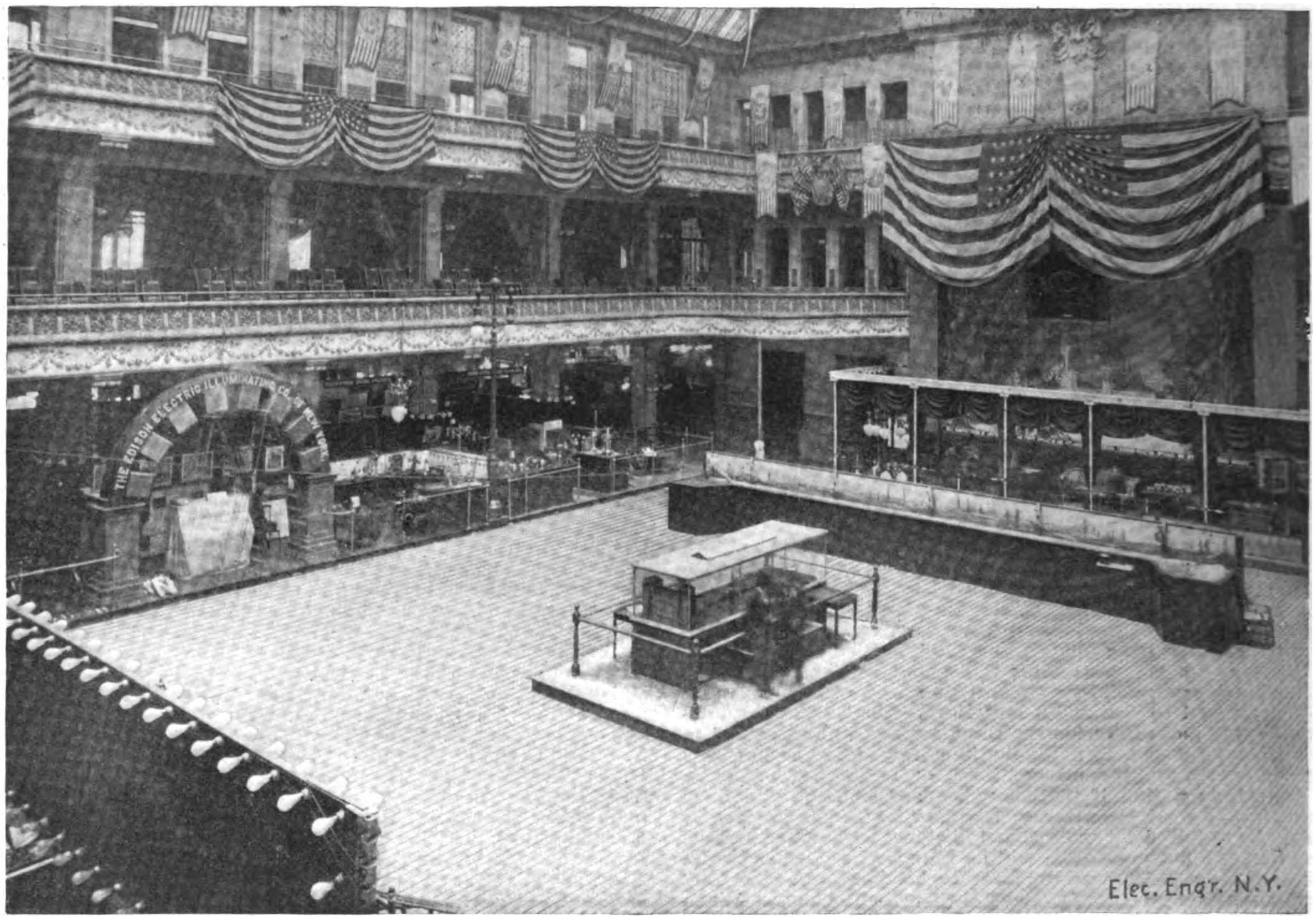
THE AMERICAN CIRCULAR LOOM CO., of Boston, had a handsome suite of rooms on the first floor of the Murray Hill Hotel, where they entertained large crowds of visitors during the life of the convention. The rooms were in charge of Messrs. H. H. Brooks, A. T. Clark, C. D. Doubleday, J. Wilson and others, who were kept extremely busy dispensing the hospitalities for which their company have established an enviable reputation. It may interest our readers to know that Mr. Brooks has permanently left Chicago, where he has resided during the past winter, and will once more take up his headquarters in the East.

PROF. H. G. BOVEY, of McGill University, and his brother-in-law, Mr. Frank Redpath, were among the notable attendants at the convention and exposition. They were both greatly pleased at what they saw and at their reception by New York electrical friends. Among the entertainments was a luncheon given at the Waldorf by Mr. C. R. Huntley, the party including also Messrs. F. Nicholls, C. W. Price, J. Seely, T. C. Martin, G. Urban and J. I. Ayer.

THE LEWIS TOOL WORKS exhibit a very fine line of adjustable jaw vises. They also show a new bicycle vise which holds the frame of a bicycle very securely.

THE CROUSE-TREMAINE CARBON CO. have arranged a very attractive display of their carbon specialties. They exhibit raw material of carbon used in the manufacture of their products, which is of a very high grade. A xylophone, if one may call it by that name, made of carbon pencils, illustrates the density and durability of the material and the curved carbons employed for special arc lamps show the great strides which have been made in the manufacture of electric light carbons. This interesting exhibit, decorated with flags and bunting, is in charge of Messrs. J. B. Crouse, H. A. Tremaine and H. S. Hart.

THE GOLDEN KEY with which the exposition was opened was loaned by Gen. E. S. Greeley for the occasion. The General has added to the base in metal letters, "New York, 1896," to correspond with "Chicago, 1893," on another face. The key is jealously guarded.



View of Main Hall of the Electrical Exposition, New York, from North East Corner.

EXHIBITION NOTES.

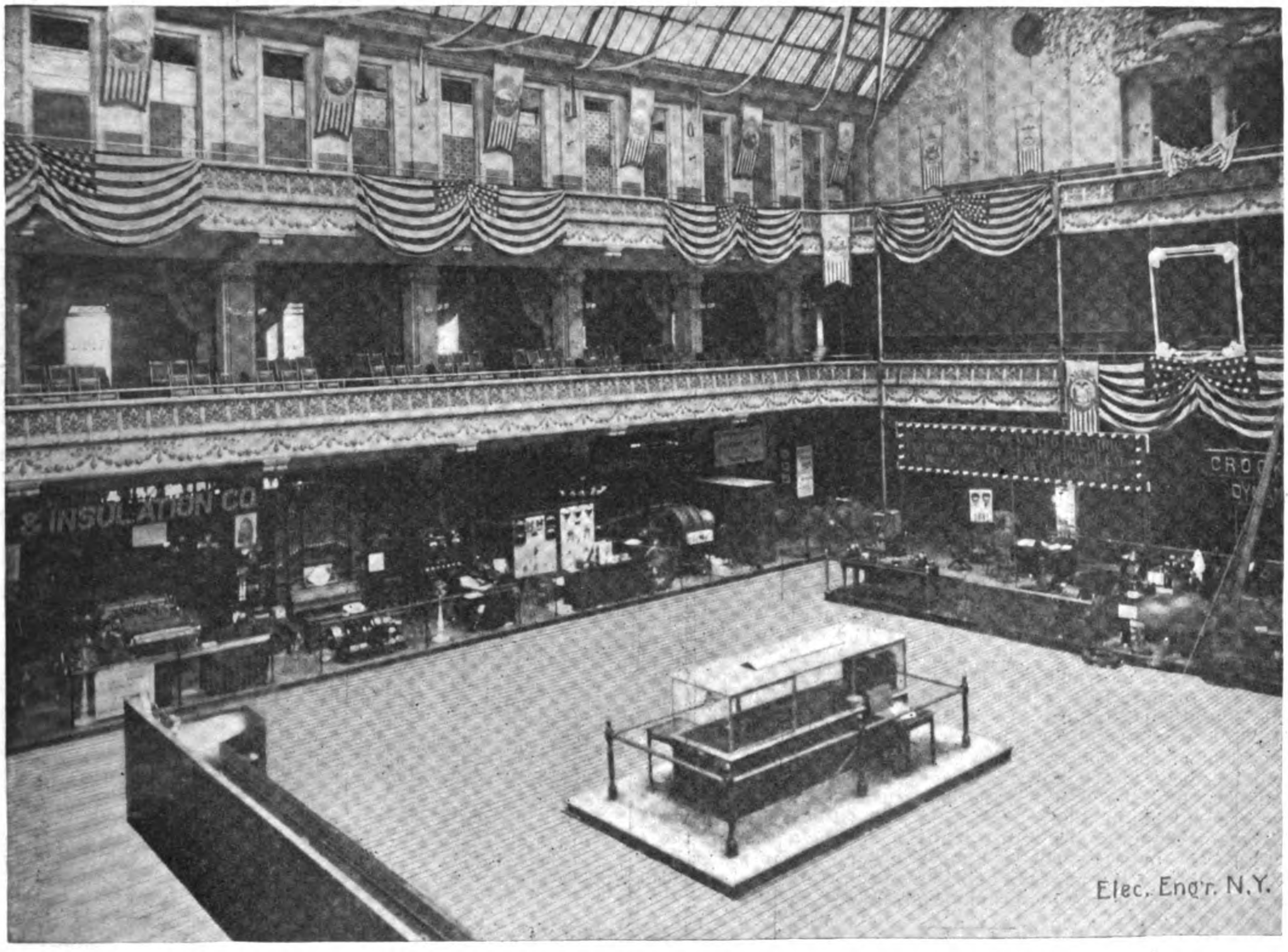
THE EXPOSITION MAIN HALL.

THE accompanying engravings represent two views of the main hall of the Electrical Exposition Building, which will give a good idea of the character and extent of the exhibits. The view taken from the northeast corner of the hall shows, at the left, the exhibit of the Edison Electric Illuminating Company, of New York, in which that enterprising company demonstrates in a practical way the numberless uses to which current can be put in the household, as an illuminant, a source of power and heat. It also shows the uses to which current can be put for public lighting, and for the operation of machinery, such as printing presses and countless other devices. At the right is the exhibit of the General Electric Company, which is more fully described elsewhere in this issue.

The long stand immediately in front of the General Electric Company's exhibit represents the model of the Erie Canal with a canal boat hauled by electricity on the Lamb system of electric haulage.

The center of the floor contains the model of the great Niagara power house, which is operated by current sent over the Western Union wires from Niagara. On the table beside it are placed a number of telephone receivers, which enable the public to hear the roar of Niagara Falls, transmitted over the wires of the American Telephone and Telegraph (Long Distance) Company.

The view taken from the southwest corner shows at the extreme left a part of the exhibit of the Interior Conduit and Insulation Company, including a printing press and an organ operated by Lundell motors. Beside it is the exhibit of the Stanley Electric Manufacturing Company, containing the large S. K. C. alternator. At the east end, in the gallery, will be seen the frame of Moore vacuum tubes, which encircled and illuminated Governor Morton as he touched the key and declared the exposition open. Below the frame are the exhibits of the Westinghouse Company and a part of the Crocker-Wheeler Electric Company's.



VIEW OF MAIN HALL OF THE ELECTRICAL EXPOSITION, NEW YORK, FROM SOUTH-WEST CORNER.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO.

Immediately upon entering the main door of the exposition is noticed the space occupied by the Westinghouse Electric and Manufacturing Company. There is a beautiful red and gold sign suspended above the exhibit, but even without that it could be easily recognized that this is the place where the Westinghouse people are holding forth, inasmuch as Tesla motors and other Westinghouse apparatus were plentifully in evidence. Mr. A. C. Zimmerman, of the New York office, and Mr. M. MacLaren, from the Pittsburg factory, are in charge of the exhibit. Mr. MacLaren has been especially detailed to look out for the power transmission from the Niagara Falls power current. The company has on exhibiton a lamp board in the center of which is seen the Shallenberger electric meter. The case of this meter is removed, and in this way the actual operation of this well-known device is plainly demonstrated, and attracts a great deal of attention. Another interesting feature is an illustration given of the principle of induction, which is demonstrated with an induction coil. The company's exhibit is lighted up with the well-known Sawyer-Man incandescent lamp. On the floor stands a 20 horse-power Tesla motor, driving a 20 horse-power D. C. generator. In addition to that, there were several other Tesla two-phase motors, single-phase motors and a number of converters. Mr. C. F. Scott, the electrician of the company; Mr. Allen, from the Philadelphia office, and Mr. E. H. Heinrichs, are in charge.

THE EXHIBIT of the Akron Insulator and Marble Company, of Ohio, at the Electrical Exposition, is in charge of Mr. Harry G. Osborne, of Chicago.

THE POSTAL WIRES ON OPENING NIGHT.

The Postal-Telegraph Company have received the following letter from the officers of the National Electric Light Association and the management of the exposition:

May 7, 1896.

Postal-Telegraph Cable Company, 253 Broadway, New York:

Gentlemen—In behalf of the management of the National Electrical Exposition, I beg to thank you for your courtesy and valuable aid in connection with the arrangement for firing guns simultaneously at San Francisco, St. Paul, New Orleans and Augusta, Me., announcing the opening of the exposition at the Grand Central Palace, New York, on Monday evening, May 4, 1896.

The circuit, which was composed throughout of the copper wires belonging to your company, was the longest circuit ever established for the purpose of firing cannon simultaneously at widely separated points, and the use of current derived from the power plant at Niagara to energize that part of the circuit between Buffalo and New York was the first time that such current was used for telegraphic purposes.

Immediately after Governor Morton had closed the circuit (by means of the gold telegraph key, which had been previously used only to start the machinery of the World's Fair at Chicago) messages were received from all of the above-named cities, announcing that the guns had been fired electrically by his closing of the circuit and without other human intervention, and telegrams of congratulation to the Governor from the Mayors of the points named followed within a remarkably brief space of time.

Your company is to be congratulated. not only upon the possession of wire facilities which enable you to accomplish this remarkable feat of long-distance telegraphy, but also upon the thorough organization and hearty co-operation of your employés throughout the country, without which it could not have been successfully accomplished.

Thanking you again for your courtesy and aid, we are,

Yours truly,
(Signed) C. H. WILMERDING,
President, National Electric Light Association.
(Signed) HARRISON J. SMITH,
President, Exposition Company.
(Signed) GEORGE F. PORTER,
Secretary.
(Signed) F. W. HAWLEY,
Chairman, Reception Committee.

A MESSAGE AROUND THE WORLD FROM THE EXPOSITION.

Great preparations are being made for the sending of a message around the world from the National Electrical Exposition, the text of which is to be prepared by Mr. Chauncey M. Depew, who is also to deliver an oration on the place and progress of electricity in modern life. The occasion will be Saturday, May 16, at 8 p. m. Mr. A. B. Chandler, president of the Postal-Telegraph and Cable Company, is to send the message for Mr. Depew from a balcony in the main hall of the Exposition Building. Across the hall, in another balcony, Mr. Edison will receive the message for Mr. E. D. Adams, the president of the Niagara Falls Power Company. The circuit will be about 28,500 miles in length, the Commercial Cable Company and the Postal wires being used for the American sections outside of South America, which will be reached via Lisbon on the message's return trip. A huge map showing the path of the message will be hung from one of the galleries. The starting of the message and its return are to be signalled in a very original way by means of novel lighting effects.

THE EXPOSITION CATALOGUE.

Owing to the great rush of exhibitors at the last minute the Official Catalogue of the National Electrical Exposition was delayed in its appearance, but was in good time after all, and was heartily welcomed. It a handsome book, well arranged, and clearly printed on good paper, useful not only as a guide, but as a souvenir. It is about 200 pages, has an ornamental cover in good taste, and sells for a quarter. The printer, Mr. J. E. Phelps, was assisted by Messrs. Stump and Rouse in its compilation.

THE EXCELSIOR ELECTRIC CO. exhibit their new type of arc machine for central station work. They have in operation a 125-light arc machine driven by a 44-horse-power multipolar motor; the arc generator supplies the hall with current. They also show an equalizer which splits a 250-volt current into halves; and a number of new style arc lamps and motors. The booth is gaily decorated and in charge of Mr. H. H. Hochhausen.

MISCELLANEOUS EXHIBITS—I.

THE BURRY PRINTING TELEGRAPH SYSTEM.

THE Patent Office exhibit in the Historical and Loan exhibition at the Electrical Exposition contains a number of telegraph models of note, but the only live telegraph exhibit in the whole exposition is the printing telegraph of Mr. John Burry, of New York. A couple of tickers are mounted on

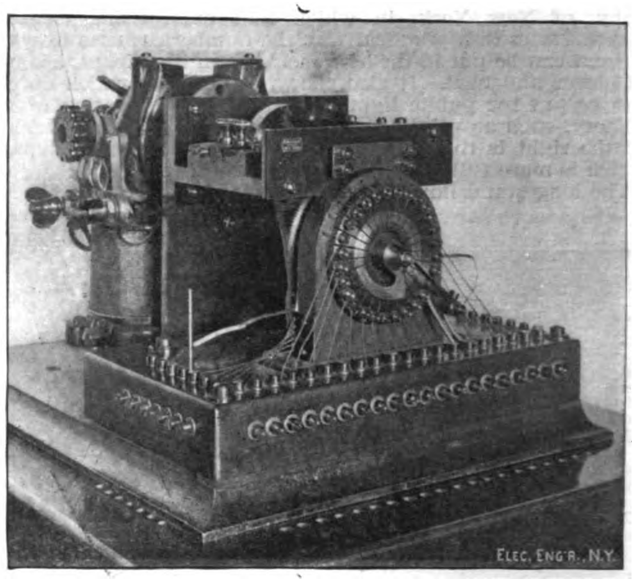


FIG. 1.—THE BURRY PRINTING TELEGRAPH TRANSMITTER.

stands, and the tapes are eagerly scanned by the lovers of baseball, and the sporting public generally.

Close beside the ticker is the transmitter used at the central office. This system has been adopted by the Stock Quotation Telegraph Company, in New York, and is in successful operation in all the large cities of the United States and Canada.

The principal instruments in the Burry system are the transmitter, Fig. 1; the ticker, or receiving instrument, Fig. 2; and the relay and keyboard, Fig. 3. Fig. 4 is a section of the switchboard in the New York office of the Stock Quotation Telegraph Company.

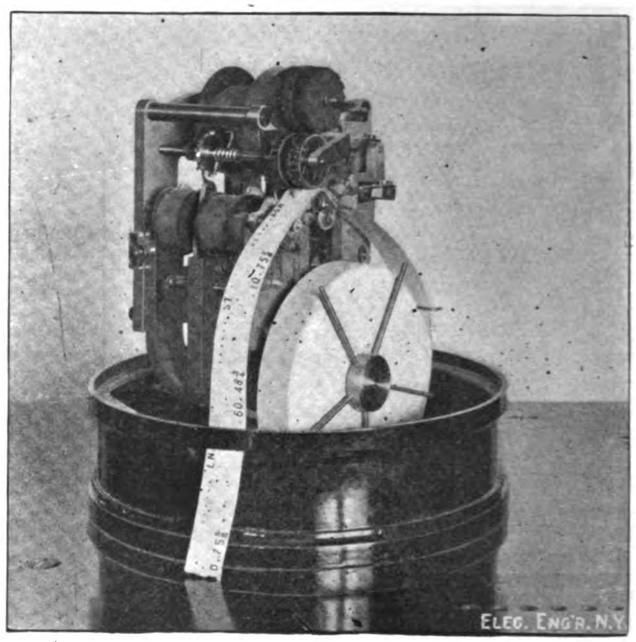


FIG. 2.—THE BURRY TICKER INSTRUMENT.

The transmitter is the apparatus which automatically controls the polarity, strength, duration and number of electrical

impulses required in the manipulation of the tickers. Its principal parts are shown in Figs. 5 and 6. Here A is an electric motor; B, a friction clutch; C, a circuit-wheel; D, a magnetic clutch; E, a gear; F, a sunflower, and A, a trailer.

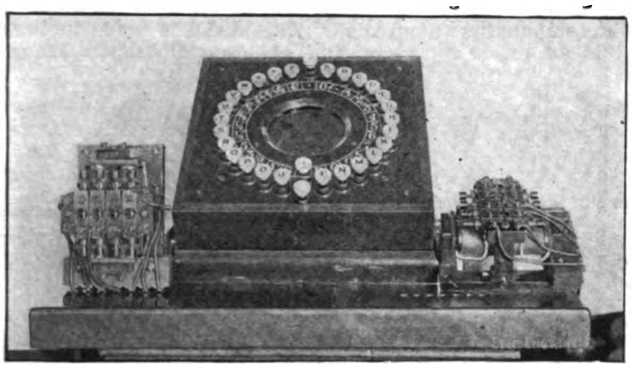


FIG. 3.—THE BURRY RELAY AND KEYBOARD.

This small, simple machine has the capacity to control simultaneously all the various functions of more than 2,000 tickers.

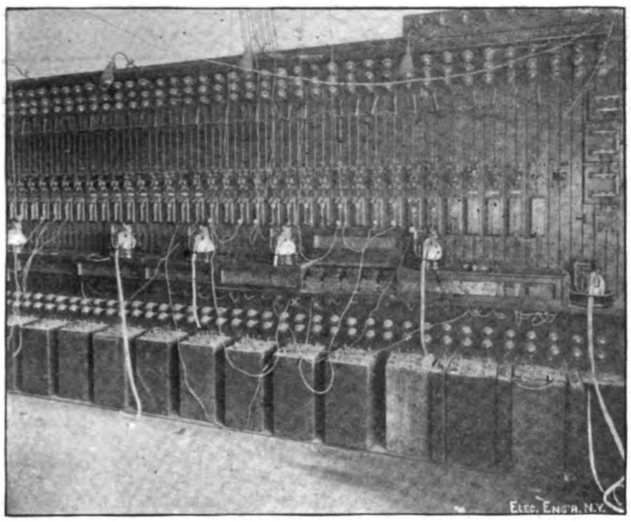


FIG. 4.—SECTION OF SWITCHBOARD IN NEW YORK OFFICE OF STOCK QUOTATION TELEGRAPH CO.

The keyboard is an automatic arrangement to control the movements of the transmitter. It is operated like a typewriter. The relay, with its resilient armature, I, Fig. 7, and stat; X and W, condensers to prevent sparking; I, armatures, and E, are the relay magnets.

By the rotation of the circuit wheel, C, the magnets, E, are alternately charged and discharged, which causes the armatures, I, to vibrate and connect + or — currents to line, as may be seen in Fig. 8.

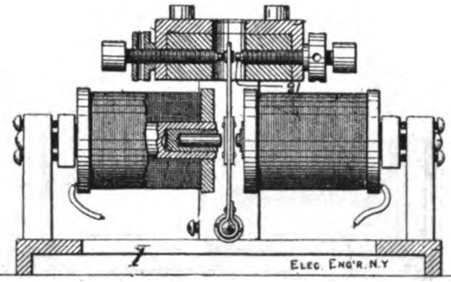
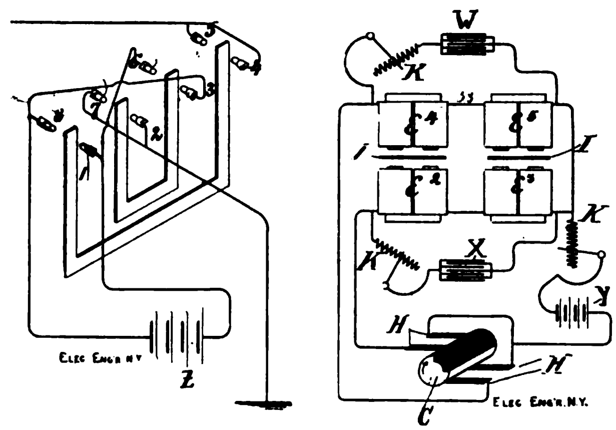


FIG. 7.—THE BURRY RELAY.

The ticker is small, neat in its appearance, requires only one line wire, prints two lines of type, and is provided with an automatic spring winding attachment.

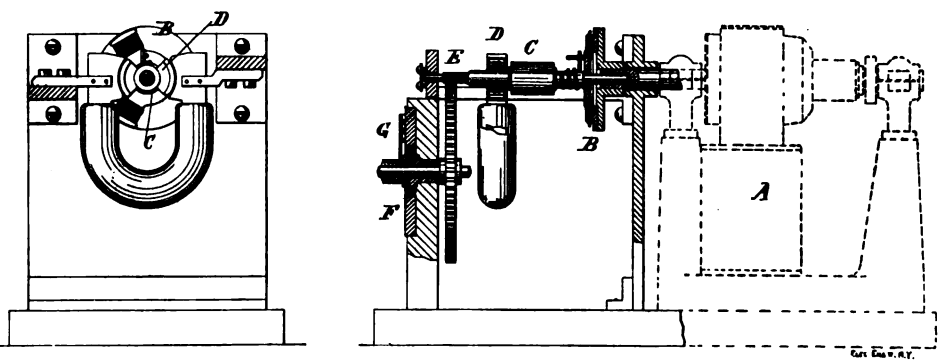
It may be of interest to note in this connection that Mr. Burry recommended the use of storage batteries for ticker service as far back as 1892, against the advice of all electrical experts. In spite of all the opposition to the scheme a battery company was induced to put in a plant for a six-months' trial. It proved to be a revelation in regard to quality of current, labor saving and general economy.



FIGS. 8 AND 9.—RELAY AND DIAGRAM OF CONNECTIONS.

A motor generator keeps up the potential of the battery, which is too small for full load during working hours, but the regular charge is delivered from the mains of the Edison Illuminating Company at night.

Mr. Paul Hoenack builds the transmitters and relays, and Mr. Oscar F. Ehrle the tickers and appurtenances of the Burry system.



FIGS. 5 AND 6.—THE BURRY TRANSMITTER—TRANSVERSE AND LONGITUDINAL SECTIONS.

number of contacts in series 1, 2, 3, 4, 5, 6, 7, 8, Fig. 8, insures a very perfect alternating current, without sparking.

Fig. 9 is a diagrammatic view of the electrical connection of the transmitter and two relays for two circuits. Y is the battery; C, the circuit wheel; H, the brushes; K, an adjustable rheo-

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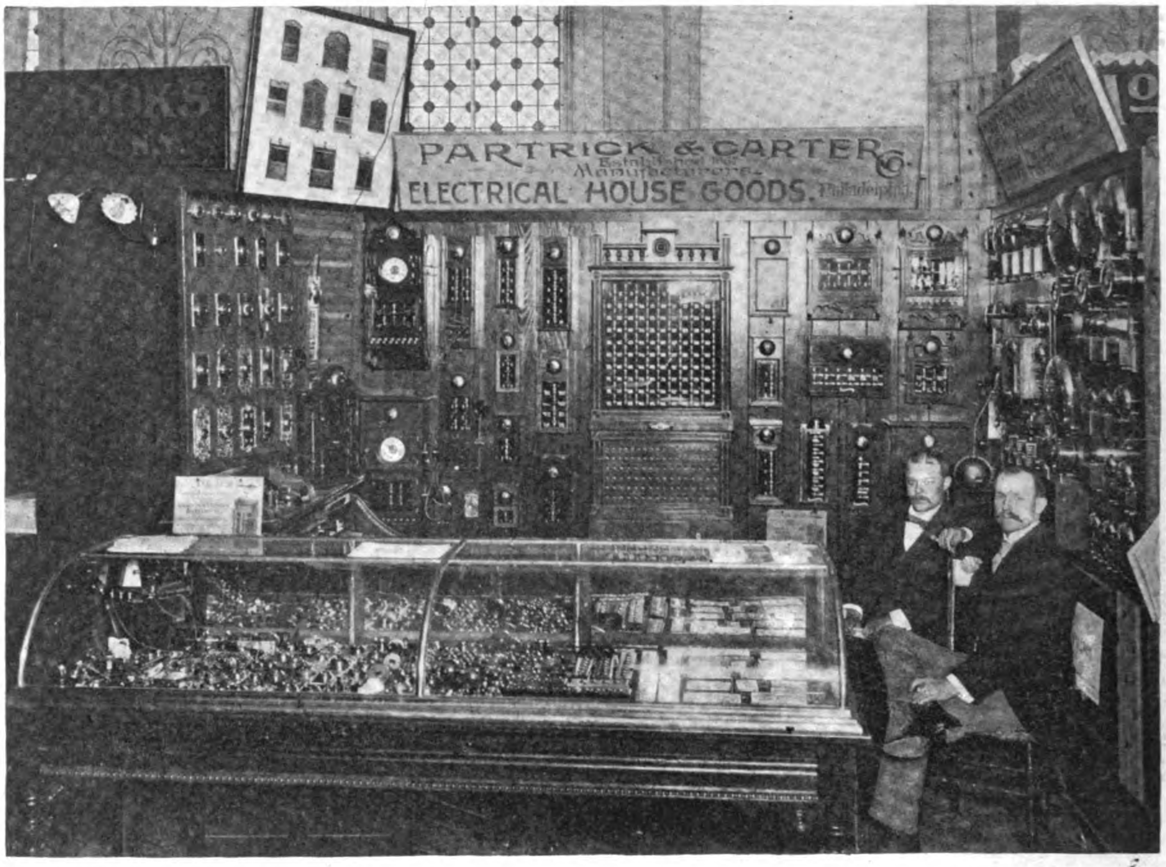
THE VACUUM OIL CO. exhibit an assortment of dynamo and engine oil. Mr. E. A. Record is in charge of the exhibit.

THE PARTRICK & CARTER EXHIBIT.

PERHAPS the most complete display of electrical supplies for hotel and general house purposes made at the exposition is that of Messrs. Partrick & Carter, of Philadelphia. To merely mention, without describing, the articles with which the exhibit fairly bristles, would occupy columns, but our readers will better appreciate the extent and character of the display by a glance at the accompanying engraving made from a photo taken on the spot.



THE PARTRICK & CARTER CO.'S EXHIBIT AT THE ELECTRICAL EXPOSITION, NEW YORK.

The exhibit is in charge of Mr. T. L. Townsend, who never tires of answering the calls which come over the Simplex-Interior Telephone system, for which the company manufactures hotel office boards, one of which forms a prominent feature on the rear wall of the exhibit.

THE EDISON EXHIBIT OF ROENTGEN RAYS AND FLUOROSCOPE.

Mr. Edison has very generously placed at the disposal of the exposition a part of his laboratory staff and some of his apparatus for making an exhibit of Röntgen effects. A special room, with the appropriate annexes and ante-chambers, has been fitted up under the expert guidance of Mr. Luther Stieringer, with somber black drapings and dull red lamps, so that the public can get the best effect. A fluorescent screen, about 18 by 22 inches, is arranged on a large platform in such a way that two persons can come forward and see their own anatomy, etc., in a few seconds and then make room for somebody else. The whole plan has been most ingeniously worked out and has received Mr. Edison's personal attention and approval, hours of uninterrupted work having been given by him to it. The exhibition will be given by Mr. Edison's staff under the supervision of Mr. Max Osterberg, who has the adjoining laboratory exhibit. The scheme is so laid out that several thousand people can pass through the dark hall in a single evening.

THE SIEMENS & HALSKE CO. exhibit consists of a 100 kilowatt multipolar generator driven by a Ball & Wood engine direct connected. The pole pieces are within the armature, the peripheral conductors of which are bare and against which the brushes bear. The combination is a very neat one.

A HANDSOME SOUVENIR.

THE Wagner Electric Manufacturing Company, of St. Louis, during the convention presented their friends with very handsome souvenirs in the shape of an ink well, as shown in the accompanying illustration. The model is made in brass, and is an exact representation of the well-known Wagner transformer, being made to scale in the factory of the Wagner Company in St. Louis. Every central station manager interested in transformers who was not fortunate enough to procure one should write the Wagner Company without delay and get one for his desk, as there are only a few of them left.

THE WAGNER TRANSFORMER INK WELL.

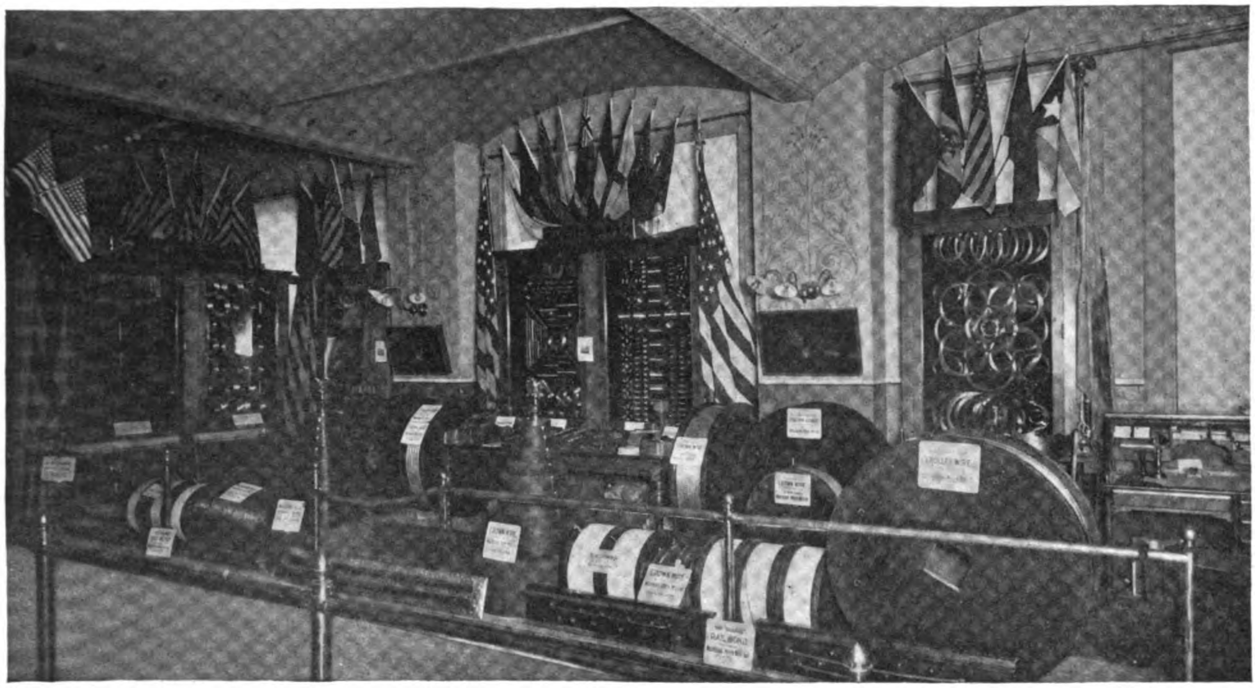
MR. A. O. SCHOONMAKER'S exhibit consists of a full line of mica segments, washes and discs. Mr. Dunning is in charge of the booth.

THE WASHBURN & MOEN MANUFACTURING CO.'S EXHIBIT.

ONE of the most attractive and interesting displays at the exposition is found in spaces 14-17, section A, main floor, and in this beautifully decorated inclosure the Washburn & Moen Manufacturing Company exhibit their well-known cables and wires.

Besides a general exhibit of all kinds of wires for lighting and railway purposes, the glass cases which line the walls contain samples of bare, high grade copper wire. Among these is a copper wire .0025 inch in diameter; 10¼ miles of it only weigh a trifle over one pound. Their well-known "Crown" wire a reel of which, lead covered for underground purposes, is also shown.

Besides this they have on exhibition a section of the main feeder wires supplying current in the exposition building, and having cross section of 2,000,000 c. m. A still larger one, 2,790,000 c. m. in section is also manufactured and is said to be the largest single electrical conductor in use in this country.



THE WASHBURN & MOEN MANUFACTURING CO.'S EXHIBIT AT THE ELECTRICAL EXPOSITION, NEW YORK.

One case contains a large number of steel models illustrating the wires of irregular shapes made by the company.

Besides these they show electric railway materials, their new 8-section trolley wire, and a reel of 500,000 c. m. cable for street railway work, which is both weatherproof and lead covered. Another prominent feature is the Chicago rail bond which has been adopted by many leading railroads, and also a handsome assortment of lamp cord, office, annunciator, and magnet wires.

This interesting exhibit is in charge of Messrs. C. W. Bassett, H. C. Willis, and D. P. Fitzgerald, Jr.

THE ALBANY LUBRICATING COMPOUND AND CUP CO. displays a full line of their well-known Albany grease goods. They also show a new spindle grease cup to be used with their grease.

THE NEW YORK INSULATED WIRE CO. made no exhibit, but received their friends at the Murray Hill Hotel in two rooms secured specially for the occasion, whence none retired unsatisfied.

THE EXHIBIT of the Payne Engine Co. shows one of their 50 horse-power, 10-inch x 10-inch engines, running a 25 kilowatt Card dynamo. The engine has a new type of governor and oiler. The unit runs practically without noise or vibration.

THE ONLY EXHIBIT of its kind is made by Mr. W. Goldstein. It consists of different samples of scale taken from boilers with the use of his scale removing compound. Mr. Goldstein himself shows how valuable an article he handles.

THE EXHIBIT of the Green Fuel Ecoomizer Co. shows an outline of the goods manufactured by the company. It consists of different parts of their economizer and complete drawings of installations made by them. Mr. W. Downs, M. E., is in charge.

THE ADAMS BAGNALL ELECTRIC CO. have succeeded admirably in showing what they can do in the way of making arc lamps. Their exhibit, though small, is very complete, showing all styles of lamps manufactured by them. Mr. A. D. Dorman has entire charge of the exhibit.

BURHORN & GRANGER, agents for the Woodbury engine, exhibited a 9 x 12 Woodbury engine, direct connected to a 25 kilowatt Fort Wayne generator. The novel feature of the engine is the Shepheard governor, which regulates within one-half of 1 per cent. Mr. Burhorn is in charge of the exhibit.

DIXON CRUCIBLE CO. succeed very well in showing what an important part their goods play in the electrical field. Their exhibit consists of graphite boxes for baking electric light carbons and filaments, graphite wedges for winding filaments, etc. Besides this, there is a full line of graphite resistance rods, and lubricating compound.

THE WATERTOWN ENGINE here in operation is a 60 horse-power, 10 x 12 engine direct connected to a 30 kilowatt Eddy dynamo. A striking feature of this exhibit is the fact that the engine and dynamo are not bolted to the foundation, and yet are practically free from any vibration. The engine has a patented governor guard, which attracts considerable interest.

L. KATZENSTEIN & CO. show their metallic piston rod packing. As an example they exhibit a duplicate packing that was used on the high pressure rod of the steamer Priscilla, running at 160 pounds pressure on a 9⅝-inch rod; also a ship joint packing used on the gunboats of the United States Navy. This packing is a flexible hollow brass tube, and suitable for all pressures. Mr. F. T. Halt is in charge.

THE ASHTON VALVE CO. display quite a variety of valves and gauges, including safety valves, steam gauges, clocks, engine register, water relief valves, hydraulic valves, locomotive valves, locomotive muffler valves, etc. In the same booth with the Ashton Valve Co., the Mason Regulator Co. have an exhibit of their reducing valves, regulator pumps, etc. Both exhibits are under the charge of Mr. T. D. Oaks.

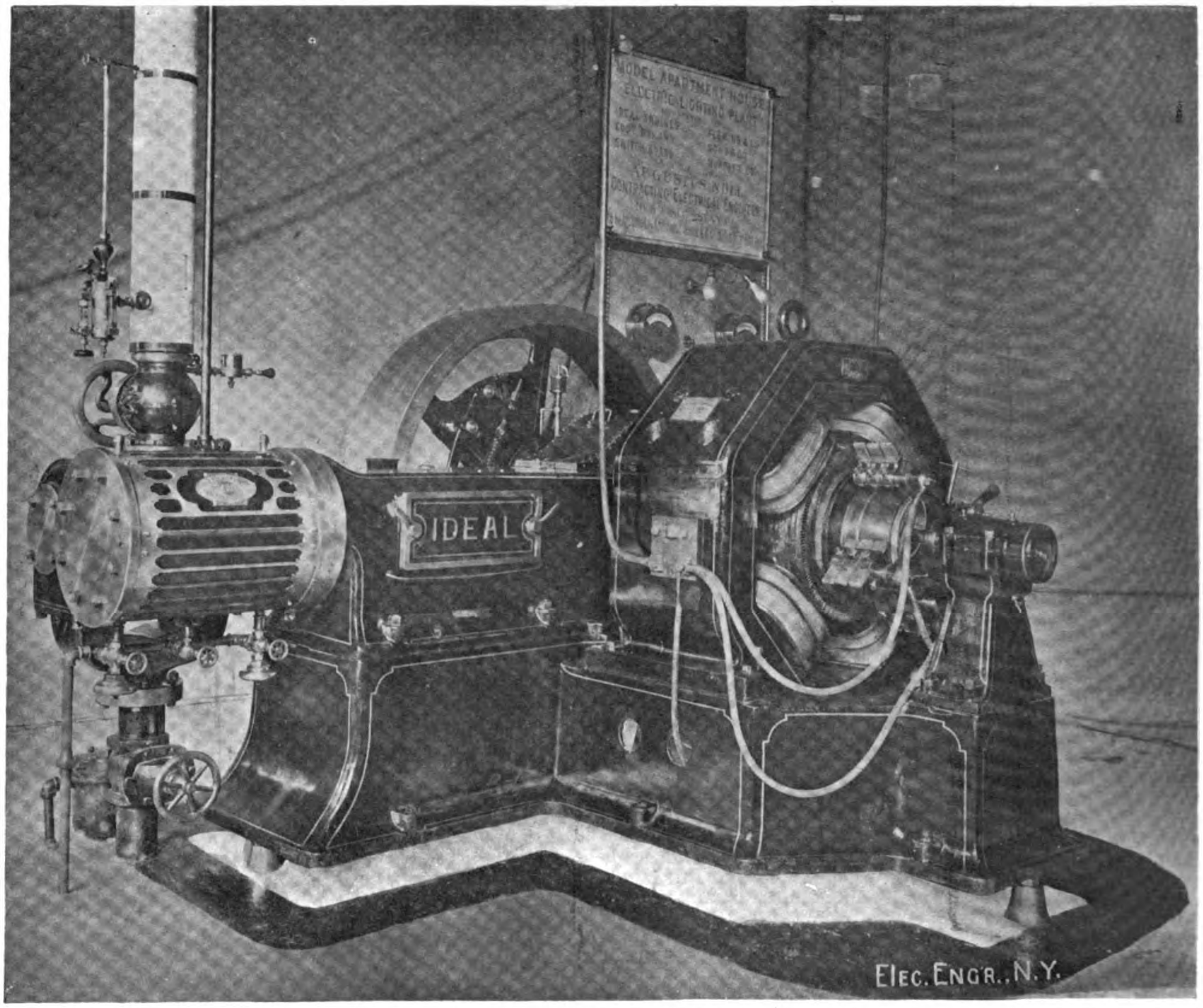
SCHULTZ BELTING CO.—A fine exhibit is made by Mr. A. B. Laurence, of the Schultz Belting Co. It consists of belts of all varieties, including flat sable rawhide, flat sable rawhide grooved, flat sable line or woven belts. There is also shown the Schultz patented pulley cover and rawhide rope, and rolls of 72-inch, 24-inch and 16-inch belts. These belts are the only ones used in the exposition generating plant. A feature of the exhibit is a model of the company's trade mark—a belt between the earth and moon makes the latter spin like a top. Mr. A. C. Laurence did all the electrical work on the model. Mr. A. B. Laurence designed it. The exhibit was in charge of Mr. A. B. Laurence.

THE EDDY DYNAMO AND HARRISBURG "IDEAL" ENGINE EXHIBIT.

If a vote were to be taken among the visitors to the Electrical Exposition as to the finest direct-connected unit in the generating plant, there is little doubt that the Eddy dynamo and Harrisburg "Ideal" engine unit would carry the day, if one may judge by the comments one hears.

This generator was the first to go into operation at the exposition, and from the very start has been called upon to carry continuously an overload varying all the way from 10 to 40 per cent., which it has done without a murmur, so to speak. This would speak well for the combination in any event, but when to this is added the fact that the unit rests on but three steel points without foundation bolts or fastening to the foundation whatever, the fact accomplished will be better appreciated. As our engraving shows, the unit is supported on three points, one placed under the cylinder end of the engine, one under the crank end, and one under the dynamo. These steel points raise the whole about four inches above the floor level, and incandescent lamps placed within the base frame illuminate the floor space occupied by the engine and serve to convince the skeptical that there is daylight between the engine and the foundation.

The combination is of 50 kilowatts capacity, and runs at 280 revolutions per minute. It shows to what a fine point high-speed machinery has been brought in the matter of quiet running and freedom from vibration, and demonstrates that it is possible to have an electric plant in full operation in a room where ordinary conversation is going on without disturbing the conversers in any way, and that the old roar of a central station will soon be a thing of the past. The exhibitors of this combination, Messrs. Coho & Co. and Messrs. Fleming & Co., of No. 203 Broadway, New York, ask us to say that they will be glad to show interested parties a number of modern apartment and office building plants in operation at any time.



THE EDDY DYNAMO AND HARRISBURG "IDEAL" ENGINE UNIT ON STILTS, AT THE ELECTRICAL EXPOSITION.

THE GENERAL ELECTRIC CO.—The space occupied by the company is at the base of the south wall of the main hall. It is inclosed by a pillared cornice studded on the outside with a line of special 6 c. p. miniature yellow lamps broken at the top of each pillar, and on the inside with 240 volt, 16 c. p. frosted lamps. Above the space against the wall is a large monogram, with the initials of the company set in different colored miniature lamps.

The right of the space is occupied by a stand supporting a number of swivelled frames containing photographs of some of the important work done by the General Electric Company, such as the 96-ton Baltimore and Ohio electric locomotive, the great Portland and Sacramento power transmissions, and other installations of similar magnitude. To the left of the space stands an ornamental iron standard carrying arc lamps of the constant potential, long-burning, direct and alternating incandescent and power circuit types. On the tables are a number of samples of the new line of measuring instruments for alternating circuits, some of the new alternating current fan motors, and two samples of the new type H transformers. The space is inclosed with a unique railing formed of railway feeder cable supported by insulated suspension and turnbuckles.

The Miniature Lamp Department has an exhibit of its own placed in a small room to the left of the main space. The principal feature of this is a display board, on which is mounted a sample of every kind of incandescent lamp, outside the miniature category, manufactured by the company. On a stand in the center of the room are two boards, one

carrying a variety of samples of candelabra, miniature and decorative lamps, and other samples of battery lamps. In this case, the smallest incandescent lamp manufactured is shown—about the size of a small pea.

Several of the ornamental illuminated designs gotten up by this department are used to embellish the room. Attached to the ceiling is a beautiful sun; the wall is adorned with a four leaved clover and horseshoe, and a patriotic device with the eagle surmounts the U. S. shield, on which the colors are shown in small lamps. The two other designs are entitled "Mischief Brewing," and "Homeward Bound." The first represents a little witch bending over a seething pot beneath which glistens a red fire, while fays and sprites appear and disappear and a grewsome green-eyed cat glowers from beneath the witch's pointed hat. 'Homeward Bound" is a full-rigged shop tossing and pitching on her way through the moonlit waters, her port and starboard light showing as she appears sailing toward the spectator.

The company was represented by Messrs. S. D. Greene, J. R. Lovejoy, W. L. R. Emmet, J. Kirkland, H. C. Wirt, W. Fenton and J. M. Andrews, of the Schenectady office; Messrs. Charles T. Hughes, T. Beran, C. Gundaker, C. G. Davenport, George De B. Greene and others, from the New York office; Messrs. C. B. Davis, F. M. Kimball, Haley, Ives and Bush, of the Boston office; H. J. Buddy, of the Philadelphia office; W. F. Hays, of the Cincinnati office; A. E. Giles, of the Atlanta office, and Messrs. A. D. Page, M. K. Eyre and McAllister, of the lamp works, at Harrison, N. J.

PERSONAL.

ARCHIBALD J. MARTIN.

WE give herewith the portrait of Mr. A. J. Martin, the electrical engineer of the exposition now being given under the auspices of the National Electric Light Association. He first entered the electrical field in 1880 with the old concern of Arnoux & Hochhausen, merged later into the present well-known Excelsior Company. In 1884 he resigned to accept a position with the Thomson-Houston Electric Company, in connection with the work of installing stations and operating them. This work he continued down to 1890. Among the large plants thus put in by Mr. Martin was one, on the Thomson-Houston system, for the West End Electric Company, of Philadelphia, costing over $400,000, and another for the Germantown Electric Company, of Philadelphia, costing over $200,000.

A. J. MARTIN.

During the past three years Mr. Martin has been connected with Mr. John A. Seely as superintendent of construction. The Fourth Street Railway Company's station of St. Louis is one of the latest plants installed under Mr. Martin's supervision. Those who have come in contact with him in the exposition work have found him alert, energetic, courteous and full of executive ability. The work of getting the power plant and wiring of such a remarkably large expositon in shape within practically a week has been literally gigantic, but it has been carried out with great credit by the subject of this sketch.

MR. LUTHER STIERINGER.

While studiously avoiding any official capacity, Mr. Luther Stieringer has placed his eminent expert and executive ability at the disposal of the exposition management, and the good results are visible in every department. Few men have had so much experience in expositions or can tell better what effect will be secured if certain things are done; and where an exposition looms up so suddenly with unexpected importance and magnitude right guidance is at once rare and invaluable. Mr. Stieringer has again earned the hearty thanks of the profession. To specify but one feature, his artistic setting of the Röntgen ray and Edison fluoroscope exhibit must be regarded as one of the most skillful and artistic arrangements of the kind ever attempted. A delicate scientific experiment is shown to thousands under the best conditions, with every accessory helping to secure the desired result.

FREDERIC NICHOLLS.

THE new president of the National Electric Light Association is one of the most representative men to have reached that place of honor and distinction. Of good English birth and German education, he has been a great many years in Canada; while his business relations with the United States have always been intimate, and his friends in this country are innumerable. Mr. Nicholls has long been an active and loyal member of the Association, and was early picked out as an officer for the body. He is not only deeply interested in the success of local plants, in which he has placed large sums of money, but as an electrical manufacturer turning out perhaps the largest variety of electrical apparatus made by any single concern under the British flag, he is able to look calmly and fairly at the commercial questions of the industry, from the standpoint of the seller and the buyer alike. His judgment is sound and shrewd, and he can take long views as well as swift actions.

FREDERIC NICHOLLS, PRESIDENT, N. E. L. A.

As the vice-president and general manager of the Canadian General Electric Company, Mr. Nicholls is held in high esteem in manufacturing circles in Canada, where he is also distinguished as being with tongue and pen a foremost advocate of a protective system for the Dominion. He is also director in the Toronto Electric Light Company; president of the Brantford Street Railway Company; vice-president of the Peterboro Street Railway Company; secretary of the London Electric Light Company; and director in the Toronto and Scarboro Railway Company. A number of other enterprises all looking to the development of Canada engage his thought, and no man is more anxious for her growth and prosperity in friendly touch with America while without loss of affection for the mother country. In Toronto where the Canadian General Electric Company has its official headquarters, Mr. Nicholls is to be found handsomely installed in a fine big building where the product of the big Peterboro factory is marketed.

PROF. ELIHU THOMSON.

The whole electrical community will be distressed to learn that Prof. Elihu Thomson while riding a bicycle tandem last week had the misfortune to encounter a boulder and break an ankle bone. His presence at the convention and exposition had been confidently looked for, and it is widely hoped that he may be able to get about in time to attend and give a few demonstrations with his own apparatus. It is a curious coincidence that the same week Mr. Edison trod on a buckle and wounded his foot quite severely, but not so as to prevent his walking.

Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

WESTERN TELEPHONE CONSTRUCTION CO.'S PROGRESSIVE WORK.

We have the subjoined item of news from the Western Telephone Construction Company of Chicago:

"The Western Telephone Construction Company during the past week closed the largest single contract for a telephone exchange equipment ever made, either by an independent manufacturer or by the Bell Company. The contract covers nearly seven thousand telephones and switchboard equipment to match. This equipment is for a large American city, the location being still kept secret. It is asserted that this system will demonstrate a central office system as much superior to the Bell 'Express' system as the latter is to the old Gilliland. It is confidently expected that the new Keelyn system for large exchanges (which has quietly been perfected, awaiting the development of large exchanges) will prove a genuine surprise to the telephone people both in and outside the Bell Company. Competent telephone engineers, who have seen the first installment of these switchboards and witnessed their operation, have been astonished at the simplicity of operation and uniqueness of design for rapid manipulation. Mr. Keelyn's design is a radical departure from multiple drop systems, which, he holds, should have been displaced by better methods long since. Mr. Keelyn has provided a districting system purely original with him, and covered by patents, which admits of extending the system from one thousand to ten thousand, without any radical changes in the switchboards proper. He claims that this is the only method yet devised which will admit of large extensions without change of switchboard, except by the slower type or old transfer-jack systems which he also holds will necessarily have to give way to something capable of rapid and good service. The transfer system requires an extra board for every two boards used in a system of one thousand to twelve hundred, and then, although using a large number of operators, is too slow and troublesome for even fair service. The new Keelyn multiple system only requires the number of drops and jacks to correspond with the number of subscribers' lines.

MICA INSULATOR CO.

The Mica Insulator Company, manufacturers of the well-known insulation "Micanite," whose factories are at Schenectady, New York and London, announce to the trade that they have opened a branch house at 153 Lake street, Chicago, where they will carry a full line of "Micanite" plates, commutator rings and segments and slot insulations for all the standard railway motors and power generators, "Micanite" and empire cloth and paper. The company's goods were formerly sold in Chicago through W. H. Sills & Co., as sales agents. The business will be under the management of Mr. Chas. E. Coleman, who has been connected with the New York house for several years and is thoroughly familiar with the electrical trade. In the circular announcements that they are sending to the trade, they give the assurance that all business will receive prompt and careful attention. On account of the increased business of the company, they have been compelled to establish this branch house, which move will, no doubt, be highly appreciated by the Western customers on account of the excellent facilities which they will have for receiving "Micanite" promptly. Eugene Munsell & Company have also opened a Chicago branch at the came place, under Mr. Coleman's care.

GRUTTING SPECIALTIES.

The Grutting electric soldering iron and curling iron heaters are rapidly becoming recognized as standard goods. The Electric Appliance Company, of Chicago, as general Western agents are carrying a stock of these goods which are meeting with ready sale.

"SHIP" CARBONS OF THE STANDARD PAINT CO.

Mr. John Jordan, of Schiff, Jordan & Company, of Vienna, is now in New York. The Standard Paint Company are sole agents and importers of the "Ship" carbons manufactured by Schiff, Jordan & Company, and Mr. Jordan is here looking over matters generally, and before returning will visit all the large cities in the United States. The company are now making an active push on carbons with very gratifying results. We quote from a letter just received from one of their best customers: "As far as we can learn all of our customers to whom we have sold the 'Ship' carbons have found them perfectly satisfactory." The Standard Paint Company have just received large consignments of carbons from Vienna and are therefore in a position to fill orders immediately from stock.

ARMORITE INTERIOR CONDUIT.

The Armorite Interior Conduit Company, of 478-480 Fort street, West, Detroit, Mich., have issued a little pamphlet and price list describing their new Armorite system of interior conduits.

The tubes are made any size from 5/8 inch inside diameter to 3 inches, all 10 foot lengths. The tubes are lined with a thoroughly prepared wood, cut in semi-cylindrical sections and forced into the armor, making, when complete, insulation of the highest character.

The Armorite system is claimed to possess many advantages over the present method of installing iron conduit. Ordinary bends up to 1-inch conduit can be made cold on the job by the workmen.

THE HOPE ELECTRIC APPLIANCE CO., of Providence, R. I., report business very good in the specialties which they make, an excellent idea of which may be had from consulting their page advertisement in this week's issue. Mr. Robert A. Fessenden, treasurer of this company, was recently in New York, and favored this office with a call, when he informed us that they were now putting on the market a new knife motor switch in which the make and break is instantaneous, and the movement cannot possibly be centered. The company have recently been reorganized and are now in good shape to fill orders promptly and to manufacture a first-class line of electrical specialties.

THE AKRON SMOKING PIPE CO. have moved their factory to Mogadore from Akron, O., where they have an extensive new plant, and are turning out a vast quantity of porcelain to fill the increased orders, which they have recently received. The company has found considerable demand for their goods in the East as well as West.

H. B. CAMP CO., of Aultman, O., have had very great success with their vitrified clay conduit, which is laid in mortar or cement, making it capable of sustaining great weight in case of being undermined, as it is then one continuous solid cemented mass. The conduit is laid with the patent mandrel system of Mr. Camp. The conduit is extensively used in different parts of the country. The Cataract Construction Company have employed it; the Metropolitan Street Railway Company, Washington, D. C., have used 50,000 feet; Pittsburg, Pa., has 800,000 feet, and in Philadelphia there are 900,000 feet in use.

DORNER & DUTTON MANUFACTURING CO., Cleveland, O., report business good and the outlook for the coming year as bright. They are filling an order for seventeen trucks, D. F. Henry patent, for the Federal Street and Pleasant Valley Railway, of Pittsburg, Pa. They also are building thirty of their 25-A trucks for the Fort Wayne Consolidated road, and have recently shipped five trucks to Bangkok, Siam, where there are already twenty-five in use. This company is just bringing out a novel car heater for electric roads, which is light, compact and economical. The company is also the agent of the Compo Brake Shoe for the Central, Western and Southern States.

ON WEDNESDAY, MAY 20, at 12 o'clock, at the Real Estate Salesroom, No. 111 Broadway, New York, exclusive selling right under Letters Patent No. 457,842, covering the swinging ball lightning arrester, also Letters Patent No. 284,460, relating to cloth steepers for copying presses, will be sold at public aution.

MR. FRED M. LOCKE, of Victor, N. Y., has had some very flattering testimonial letters from electric light men and others concerning his specialties. His insulator pin is guaranteed against breakage, and his porcelain insulators will carry any amount of current safely. He is paying particular attention to the overhead construction of lines for all classes of electrical work.

THE MECHANICAL AND ELECTRICAL MANUFACTURING CO., of Brooklyn, begins business with a capital stock of $50,000. Among those interested are E. Denning, W. E. Dillman, C. Olsen, and W. G. Lord, of Brooklyn, and Ely Pullen, of Jersey City.

THE NON-POLARIZING DRY BATTERY CO. has been formed in this city by J. C. Kaempter, J. Liebes, and A. Liebes, with a capital stock of $100,000.

THE BERLIN IRON BRIDGE COMPANY have issued a neat and pretty calendar for 1896, giving pictures in color of their work in bridges, roofs, power houses, etc.

Department News Items will be found in advertising pages.

THE
Electrical Engineer.
Vol. XXI. MAY 20, 1896. No. 420.

POWER TRANSMISSION.

LONG DISTANCE POWER TRANSMISSION AT LOWELL, MICH.

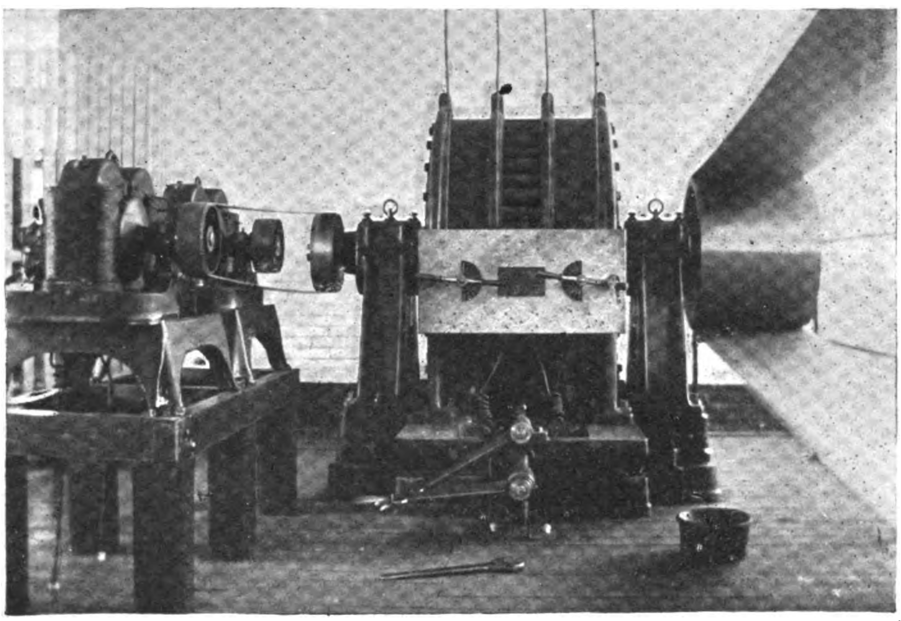
BY J. B. W.

ONE of the most typical and the longest electric transmission plants east of the Mississippi River has recently been installed at Lowell, Mich., by the Lowell Water and Light Company. The power house is situated about one mile east of the town upon the Flat River, a tributary of the Grand. On the east side of the river is a large waste weir, which is used in time of high water. The power house, a substantial brick building, is located upon the west bank.

In the basement of the building are three vertical turbines of 100 horse-power capacity each, two of them being Leffel, and one a new American special. These wheels furnish power for driving one 200 kilowatt "S. K. C." alternating current generator. The pumping machinery which supplies water for the village of Lowell is also located here. The wheels are so arranged that any one may be connected or disconnected to the machine line shaft by means of clutches, thus making it possible to throw any wheel in or out without shutting down the plant. The generator is belted to this line shaft and supplies current at 1,000 volts. The town of Lowell is supplied at this voltage. Step-up transformers raise the current from 1,000 to 10,000 volts, and at this high potential supply the transmission line upon which it is carried to Grand Rapids, eighteen miles away; there it is reduced by means of step-down transformers to 2,000 volts and distributed for light and power indiscriminately. Eight thousand alternations are used in this work, and the motors of the "S. K. C." type with condensers are used exclusively for power.

The marble switchboard in the Lowell station is perfect in its adaptation and equipped with the best apparatus obtainable for high voltage work. Two double-pole switches and two "S. K. C." circuit breakers control the Grand Rapids line, while the Lowell circuit is similarly controlled. The generator is furnished with regulator heads by which the voltage of either phase may be raised or lowered independently of the other, thus making it possible to throw the load of the Lowell circuit upon either phase, and yet maintain a perfect balance of voltage at Grand Rapids, over eighteen miles away.

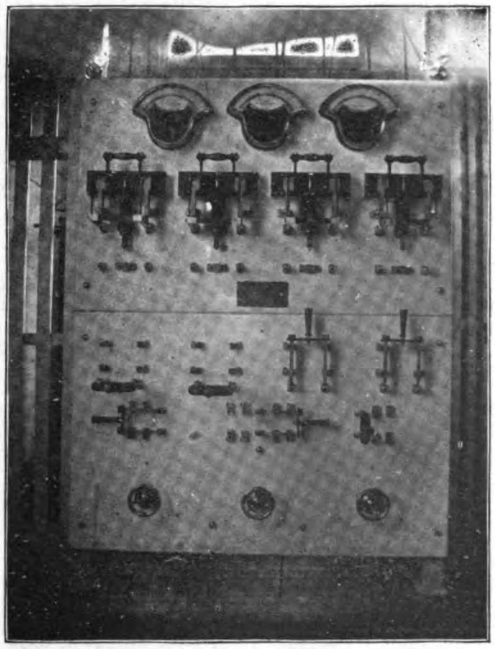
THE DAM AT LOWELL, MICH.



S. K. C. GENERATOR AND EXCITER.

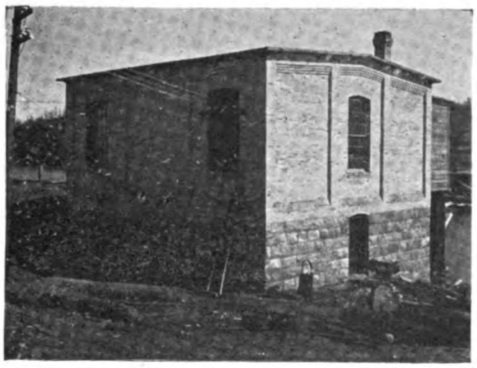
The pole line is of the most modern construction, and very substantial, consisting of 30-foot poles, with not less than six-inch tops, set 100 feet apart. The four No. 6 wires are carried upon two cross-arms, and are so arranged as to make a square having 18 inch sides, the diagonal wires of which form the circuits for each phase of the generator. They are sup-

ported upon the Locke triple petticoat porcelain insulators, which give very perfect insulation, the leakage being extremely



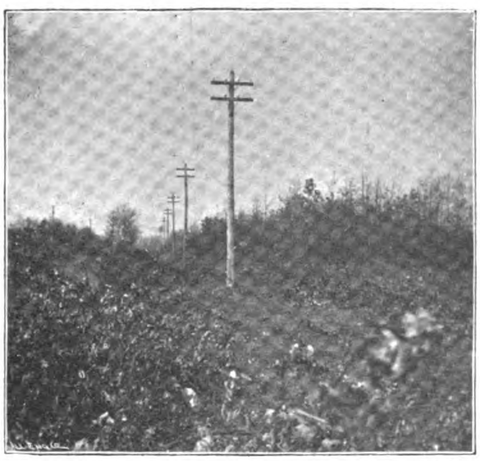
THE SWITCHBOARD AT LOWELL.

small, even with a pressure of 12,000 volts upon the lines. The circuits are protected from lightning discharges by string-



POWER HOUSE AT LOWELL, MICH.

ing a barbed-iron wire over the tops of the poles, which wire is grounded at every other pole. For indicating grounds upon the high voltage lines static ground detectors are used.



THE TRANSMISSION LINE.

The Stanley Electric Manufacturing Company, and the Lowell Water and Light Company, have in this installation practically demonstrated that power can be carried long distances at high voltages through a thickly settled region and distributed for an indiscrimate use of arc, incandescent lights and power with perfect success, and that by using these high voltages the losses in the lines can within a commercial basis be reduced to less than the average losses in the distributing circuit of low tension direct current central stations in large cities.

The officers of the company are O. C. McDonald, president; Charles A. Church, secretary and treasurer; L. W. Kutsch, superintendent. The pole line was constructed under the supervision of Mr. M. M. Wood, of Chicago, and the installation of the electrical equipment was made by W. B. Jackson, one of the engineers of the Stanley Electric Manufacturing Company.

ELECTRIC LIGHTING.

SOME ACCOUNT OF THE EVOLUTION OF THE INDUCTOR ALTERNATOR.[1]

BY JOHN F. KELLY.

In beginning this brief sketch of the evolution of the inductor alternator,[2] I wish to define my conception of the type, and I have found it necessary to include some machines not usually regarded as inductors. An inductor alternator, as I understand it, is one in which the electromotive force in the induced coil is the result, not of changes in the space relations between such coil and the flux-producing agency, but of changes in the flux through said coil, brought about by the motion of iron pieces serving as magnetic conductors. When the flux is due to an exciting coil, the foregoing definition requires constancy of the space relations between the exciting and the induced coils, and in general this constancy of relationship is mechanically expressed by the entire immobility of both coils. It is, however, possible that the inducing coil should turn on its

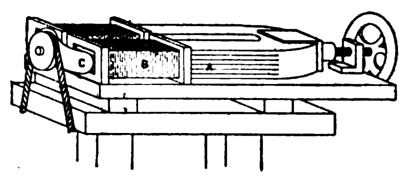


FIG. 1.—KNIGHT, 1854.—A, INDUCING MAGNETS; B, INDUCED COILS; C, ROTATING KEEPER.

axis without in any way altering its relationship to the induced, and in some cases this is the construction adopted.

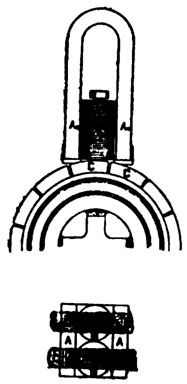
As a means of producing electric energy on a large scale, the inductor alternator is the latest claimant for public favor, and yet it is far from being a newcomer. Its advantages have been apparent from the earliest days of the art, and a long series of distinguished inventors have worked at its development. Although until about eight years ago it was an extremely inefficient generator, its extreme simplicity secured it an introduction when not much power was required. Indeed, if we bear in mind that the Bell telephone considered as a translating device, is an inductor alternator, we shall have to regard the inductor as the most widely used type of alternator. Our concern here, however, is only with machines useful in

[1] Read before the N. E. L. A., New York, May 5, 6 and 7, 1896.

[2] The almost exclusive reference to English inventors in this paper is not due to underrating the efforts of others, but solely to lack of space and time. It would have been impossible to give adequate recognition to all, and it happened to be more convenient for me to trace the development along English lines until the last stage than along any other. I have no doubt that a parallel history might be written for any of the important cultured lands. At the present time the art of inductor building is more highly developed in the United States and on the European Continent then in England. Indeed a mere mention of the name of the engineers on the Continent, engaged in the development of inductor machines—Rühlmann, Dobrowolsky, Arnold, Kolben, Brown and Thury—is sufficient evidence that their work must be of importance.

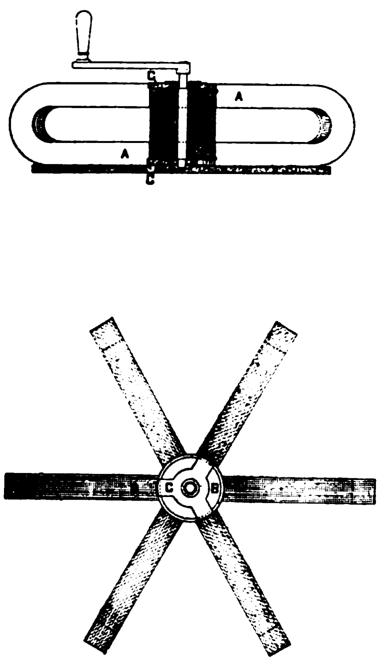
large sizes, and any others are of interest only as foreshadowings.

I shall first call your attention to Knight's machine, shown in Fig. 1. This machine was patented in 1854 in England. Its defects are obvious, but it should not be overlooked that it is



FIGS. 2 AND 2A.—HENLEY, 1856.—A A, INDUCING MAGNET; B B, INDUCED COILS; C C, KEEPERS.

not worse than its rivals of other types, and, indeed, no worse than most of the modern magnetos for signaling purposes, while it is unquestionably of a more robust construction. Henley's machine, Figs. 2 and 2a, consists of an inducing magnet with an electro-magnet set between its poles and in a plane at right angles to them. A double series of rotating keepers connects first one pole of the electro-magnet to the north pole of the inducing magnet, and the other to the south pole, and then reverses these connections, thus giving use to an alternating flux through the electro-magnet. Figs. 3 and 4 show an interesting design of Wheatstone's. There is but a single induced coil, within which moves an iron cylinder provided at each end with radial polar extensions. This single coil form has been



FIGS. 3 AND 4.—WHEATSTONE, 1858.—A A, INDUCING MAGNETS; B, INDUCED COIL; C C, KEEPERS.

taken up again by recent inventors, but has not yet come into use. Like Knight's machine, this of Wheatstone's suffers from the great variation in the magnetic flux in the inducing magnets. Wheatstone says that the inducing magnets in this machine may be electro-magnets. Fig. 5 shows another design of Wheatstone's, which shows considerable improvement over the other. The variations of magnetic flux are here confined to those portions of the magnetic circuit in which it is necessary they should occur. The flux as a whole is steady, and the machine operates by its varying distribution, the keeper now directing the flux through one pair of induced coils, now through the other. Wheatstone does not appear to have had this reason in mind in duplicating the induced pair of coils. His object appears to have been to secure a smoother electro-

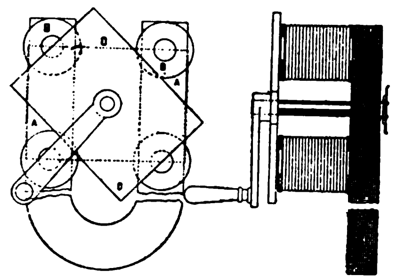
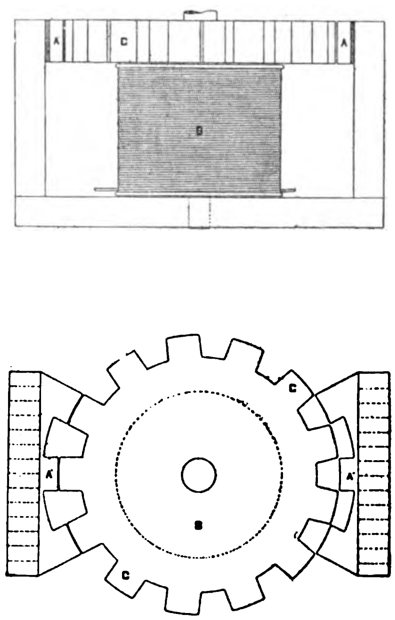


FIG. 5.—WHEATSTONE, 1858.—A A, INDUCING MAGNET; B B, INDUCED COILS; C C, KEEPERS.

motive force curve. This machine was introduced into telegraphy, and I am assured by Mr. Stephen D. Field that it gave first-class service. The Lippens machine, shown in Fig. 6, is

FIG. 6.—LIPPENS.—A A, INDUCING MAGNETS; B B, INDUCED COILS; C C, KEEPERS.

so like Wheatstone's first design that it needs no description. A machine designed by S. M. Martin and S. A. Varley is shown in Figs. 7 and 8. It consists of two inducing magnets, with an induced magnet between them, connected to the soft iron yoke.

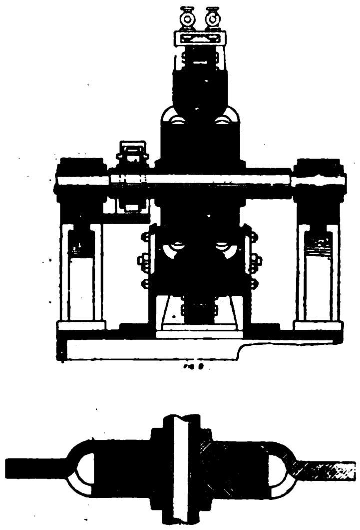


FIGS. 7 AND 8.—S. M. MART N, S. A. VARLEY, 1868.—A A', INDUCTOR POLES; B B, INDUCED COIL; C C, KEEPERS.

A revolving, toothed iron disc alternately closes the magnetic circuits of the two inducing magnets through the induced magnet. This machine may be considered to be Henley's, with one

limb of the electro-magnet suppressed, and only one limb of the inducing magnet in action at a time.

The machine described by Holmes, Figs. 9, 10 and 11, in his English patent of 1868, is worthy of considerable attention. In some respects it may be considered as an inversion of Wheatstone's first design. A single exciting coil gives rise to a number of poles, while the induced electro-magnets are separate and distinct. An interesting feature is that the cores of the induced magnets are slotted to prevent Foucault currents. The exciting coil feature has been adopted in all modren inductors with which I am acquainted, save one, and the sub-division of the iron in armatures to prevent Foucault currents has become a matter of course. Yet, in respect to the steadiness of the flux, this machine is distinctly retrogressive and decidedly inferior to Wheatstone's second design. Holmes intended the machine for electric lighting, but I am not aware of its ever having come into practical use.



FIGS. 9 AND 10.—HOLMES, 1868.—A′ A, INDUCTOR POLES; A A, EXCITING COILS; B B, INDUCED COILS; C C, KEEPERS.

Gramme's invention came near putting an end to work on inductors, as, indeed, to work on alternators of any kind. Yet, in the time intervening between the introduction of the Gramme machine and the resurgescence of the alternator, provoked by the introduction of the modern transformer, C. F. Varley[1] designed an inductor, Figs. 12 and 13, which deserves mention for its novelty. The induced coils are subject to the influence of two inducing magnets which tend to develop opposite fluxes through them. These magnets are alternately short-circuited by the keepers, and, in consequence, the flux through the induced coils is alternated by arranging the keepers so that they begin to short-circuit one inducing magnet before entirely open-circuiting the other; the flux in the inducing magnets is kept more or less constant. In this same year, Paul Jablochkoff took out an English patent for an inductor alternator. It is of the single induced-coil type; but were it not for the inventor's great fame, considering the date, it would not be worth attention.

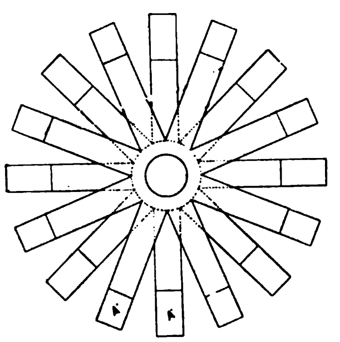


FIG. 11.—HOLMES, 1868.—A A, INDUCTOR POLES.

Even the best of these early inductors must have had vast iron losses. In most cases there was no thought of preventing them, and, when preventive measures were adopted, they were entirely inadequate. The mass of iron subject to magnetic change was always, relatively to the size of the machine, enormous, thus necessarily increasing the hysteresis loss; while no sufficient provision appears to have been made for the prevention of Foucault currents. The machine of Klimenko, exhibited at Vienna, which required more power to drive it when running light than when loaded, was not, I think, exceptional.

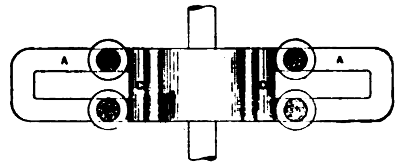


FIG. 12.—C. F. VARLEY, 1877.—A A, INDUCING MAGNETS; B B, INDUCED COILS; C C, KEEPERS.

In 1887, Mordey cut the Gordian knot by entirely suppressing the iron in the induced portion of the machine. The highly and deservedly successful machine that bears his name is shown in Figs. 15 and 16.

There is a central core surrounded by the exciting coil, A. From each end of this core projects a set of radial polar arms, which are recurved so as almost to meet one another. In the space left free are mounted the thin induced coils, BB, in a circle. The induced coils are wound in the plane of this circle, and are in number twice the polar faces on one side. The induced coils are fixed and the inducing magnet revolves. The exciting coil turns with the core, but this is electrically immaterial, and the results would be the same were it at rest. Obviously, the total reluctance of the magnetic circuit is the same, no matter what the position of the inductor. Change of flux in the iron is due only to armature reaction, and it gives rise to iron losses only because of its space variations. With a low armature reaction, such losses will be extremely small.

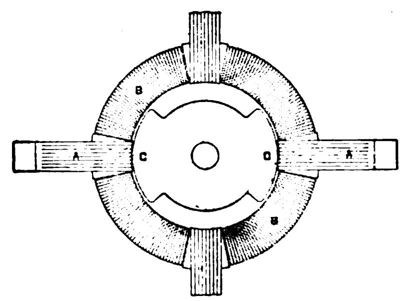


FIG. 13.—C. F. VARLEY, 1877.—A A, INDUCING MAGNETS; B B, INDUCED COILS; C C, KEEPERS.

Mordey's success, instead of putting an end to attempts to build inductors with iron in the induced portions, gave rise to a new series of efforts. Indeed, Mordey himself was foremost. His English patent of 1887, relating to the coreless armature machine, also described a machine with cores, and in subsequent patents he describes the machines shown in Figs. 17, 18, 19 and 20.

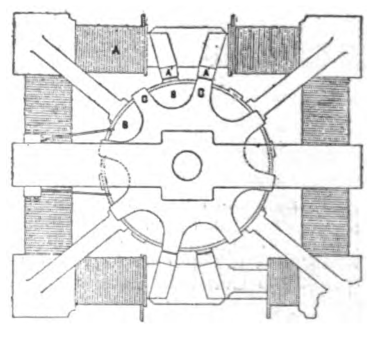


FIG. 14.—P. JABLOCHKOFF, 1877.—A A′, INDUCTOR POLES; A, EXCITING COILS; B B, INDUCED COILS; C C, KEEPERS.

[1]The figures of C. F. Varley's machine were made entirely from description. They may be quite different from those in his patent.

These machines have not come into use, and, presumably, they are not as satisfactory as the coreless machine. Yet they show a marked advance when compared with the older machines. The use of the short-circuiting pieces, C′, as well as the bridges, C, tends to make the flux constant in amount and to restrict the magnetic changes to the induced portions of the

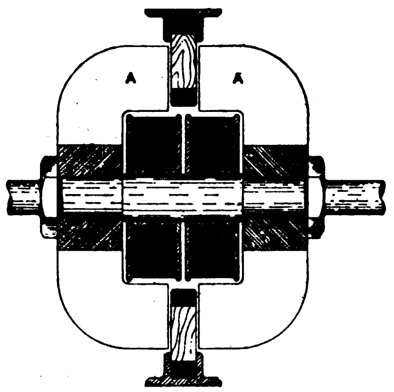


FIG. 15.—MORDEY, 1877.—A A, EXCITING COILS; A′ A′, INDUCTOR POLES; B B, INDUCED COILS.

machine. The iron subject to magnetic change is also properly laminated to prevent Foucault currents. The most obvious fault in the designs is that the mass of iron in the induced portions is large, and that all of it is subject to hysteresis loss.

In passing, it may be worth while to note one peculiarity of single induced coil machines like the earlier of the Mordey

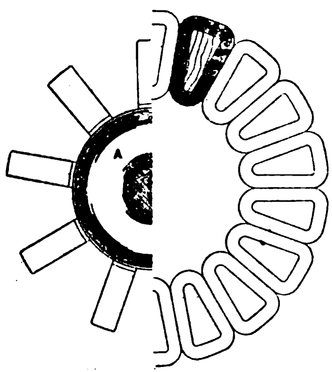


FIG. 16.—MORDEY, 1887.—A, EXCITING COILS; B, INDUCED COILS.

designs. With any given frequency, the output is independent of the speed; or, in other words, the only limit to reduction of speed is the possibility of further sub-dividing the poles. For, with the number of poles increased N times, the total change of flux takes place with 1/Nth the angular motion. This remarkable property may some day bring about the introduction of

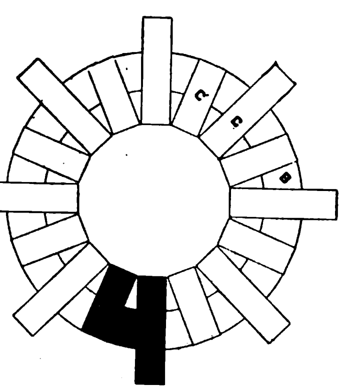


FIG. 17.—MORDEY, 1888.—B, INDUCED COIL; C C, KEEPERS.

machines of this class for direct connection to very slow-speed engines.

The Kingdon machine, Fig. 21, is a modernized Henley machine. The exciting and induced coils are wound on the alternate polar projections, and the magnetic connections between the inducing and induced cores are alternately reversed by the rotating keepers, C. The whole of the iron in the machine appears to be subject to hysteresis loss. Foucault currents are checked in the usual manner by lamination. In this machine, if the induced coils are so wound that they may be worked in parallel, it is possible to reduce the iron losses in proportion to the load by cutting out both inducing and induced coils in the same degree. I hardly think that this advantage is sufficient to countervail, having the hysteresis loss too high to begin with. A few of these machines were put into practical use, but I think not many.

The machine designed by Rankin Kennedy in 1890 is a twinned form of the Mordey, shown in Figs. 17 and 18, with the short-circuiting pieces, C′, left out. This necessitates the

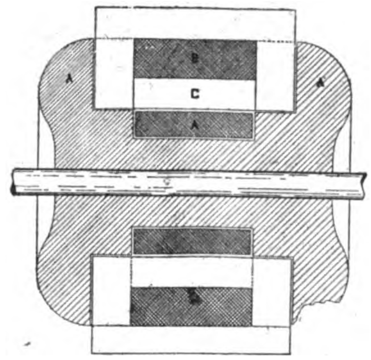


FIG. 18.—MORDEY, 1888.—A A, INDUCTOR POLES; A, EXCITING COIL; B, INDUCED COIL; C, KEEPER.

lamination of the whole of the iron, and subjects it all to hysteresis loss. The twins are so arranged that the induced electromotive forces in the inducing coils are in opposition, so as to prevent the development of alternating currents in the inducing circuit. The machine has not, I think, been practically introduced, and in my judgment it is less fitted for use than its prototype.

The modern machines thus far described lend themselves badly to polyphase working. This is true even of the standard Mordey, while as to the others, adaptation to polyphase means practically duplication or triplication of the whole machine. As polyphase machines, they are merely mechanical combinations of single-phase machines. A machine adapted directly to polyphase working, on the other hand, regulates more closely and is more efficient as a polyphase than as a single-phase machine. The machines that follow are all suitable for polyphase.

The first of them, Figs. 22 and 23, is due to one of the masters of our profession in this country, and would even on this account alone be worthy of attention. But mechanically, in the robustness and simplicity of design, it seems well in advance of its predecessors. The induced coils are well secured and out

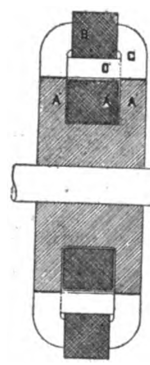


FIG. 19.—MORDEY, 1889.—A, EXCITING COILS; A A′, INDUCTOR POLES; B, INDUCED COILS; C C, KEEPERS.

of harm's way, and the only moving pieces in the machine are the shaft and the single star-shaped inductor. The adaptation of the machine to single, two or three-phase working is merely a matter of the number and grouping of the induced coils. The duplication of the exciting coil is not, I think, to be considered an improvement. High hopes were entertained of the future of this machine. Of the causes of their frustration it is not for me to speak.

The operation of the Pyke and Harris machine will be clear from the drawings, Figs. 24 and 25. The machine consists of a pot magnet with a central core. At the bottom of the pot

lies the inducing coil, A. The lip of the pot and the core carry inwardly and outwardly projecting laminated polar extensions which support the induced coils, B. Between these polar extensions move the rotary laminated keepers, C. What I have called keepers here, on account of their appearance and size, really correspond to the inductor in the Thomson machine, and in that which follows, for they normally constitute that

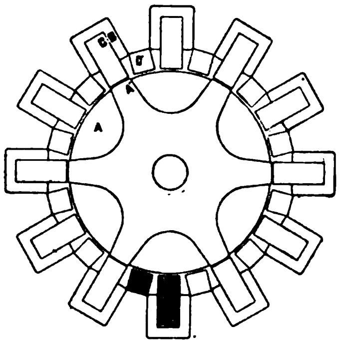


Fig. 20.—Mordey, 1889.—A, Exciting Coil; A', Inductor Pole; B, Induced Coils; C, Keepers; C', Short Circuit Keepers.

portion of the machine in which the flux is most invariable. There is no reason why a machine of this form should not be all right electrically if well designed. Mechanically, however, it seems to sacrifice that very simplicity which makes inductors desirable.

I now come to the machine with which I am best acquainted, and in whose designing I took part. For these reasons I may

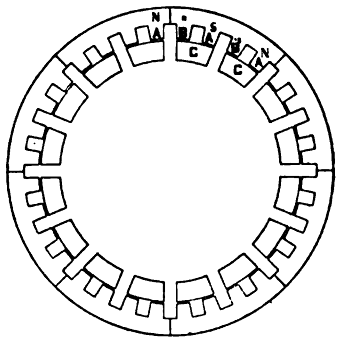


Fig. 21.—Kingdon.—A A, Inductors; B B, Induced Cores; C C, Keepers.

be pardoned for going more into detail in the description, since they enable me to give more information. Coming after that of so many able engineers, it is scarcely to be expected that the work of my colleagues and myself should result in any startling change in form, and, in fact, our improvements are not such as to catch the eye. They, however, have made the inductor alternator with iron-cored armature a success; so

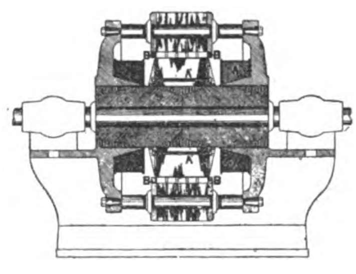


Fig. 22.—Thomson, 1890.—A' A', Inductor Poles; A A, Exciting Coils; B B, Induced Coils.

much so, that I have no hesitation is saying that the inductor is not only the alternator of to-morrow, but that it is the alternator of to-day.

Figs. 26 and 27 show clearly the construction of the machine. The rotary inductor is a cylindrical steel casting with outwardly projecting, laminated pole pieces at either end. The armature consists of two rings connected by wrought-iron tie bars. The induced coils are sunk below the surface in grooves in the armature rings, and the stationary exciting coil lies in the space between the pole-pieces and the armature rings. The machine is very effectively ventilated by means of openings in in the armature rings, and the stationary exciting coil and the spaces between the tie bars. The exciting coil itself is protected from injury by a massive hollow ring of cast copper, inside which it is wound.

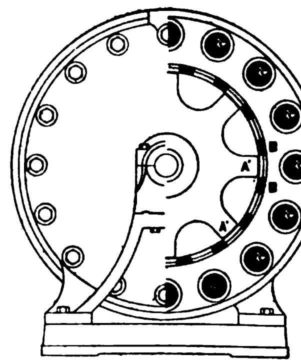


Fig. 23.—Thomson, 1890.—A' A', Inductor Poles; B B, Induced Coils.

I have already called attention to the importance of keeping the flux constant in the inductor, so as to avoid hysteresis and Foucault-current losses therein. The only thing tending to disturb the inductor flux is the varying reluctance caused by change in the relative position of the armature slots and the inductor poles. To keep this at a minimum is the chief reason

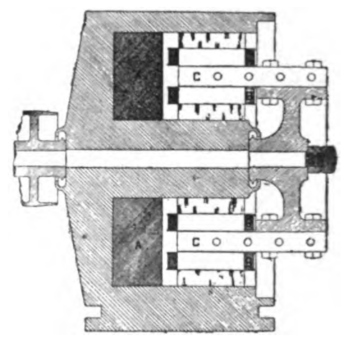


Fig. 24.—Pyke & Harris, 1892.—A A, Exciting Coils; B B, Induced Coils; C C, Keepers.

for preferring a double wreath of induced coils to a single one. Mechanical interruption at both ends is necessary in either case, and it is wise to take advantage of it in distributing the induced coils. With the same amount of wire, the space variation of reluctance is much less when both air-gaps are utilized than when only one is, and, at the same time, the regulation of

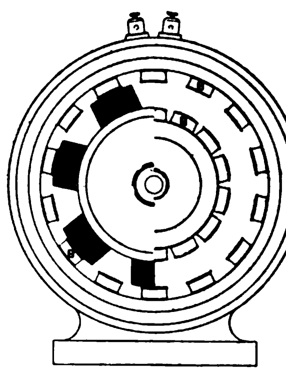
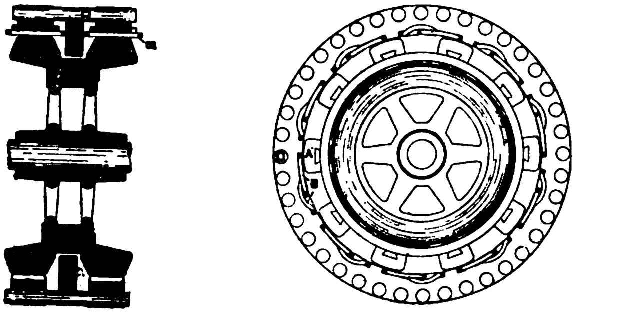


Fig. 25.—Pyke & Harris, 1892.—B B, Induced Coils; C C Keepers.

the machine is better. As complete lamination of the body of the inductor is difficult, even a slight change of flux is to be sedulously avoided. Lamination of the pole-pieces is necessary, even with constant flux, as the slots necessarily change its distribution.

But, even with the flux through the inductor constant, the

difficulties are by no means surmounted. A large mass of iron in the armature is a necessity of the construction, and the losses in this way may be such as to make the machines practically inoperative. Only thorough lamination would put an end to the Foucault losses, and thorough lamination is, for structural reasons, out of the question. Another solution is imposed. Now, when the flux is constant in the inductor, it is obvious that in amount it must also be constant in the armature. It but shifts in position without altering in magnitude. But to give rise to the electromotive force in the induced coils, it is unnecessary that the shift should take place throughout



FIGS. 26 AND 27.—"S. K. C.," 1893.—A, INDUCTOR POLES; B, INDUCED COILS; C, KEEPERS.

the mass of the armature. It is necessary only that the shift should take place through the coils; that is, to the depth to which the coils are embedded. The problem is, therefore, to combine a steady flux in the center of the armature with a shifting flux in the armature faces; or, in other words, the distribution of the flux in the middle of the armature must be independent of the points in the faces at which the flux enters. Stated in this way, analogy with the conditions of electrical distribution in parallel is suggested and this points to the solution. Consider for a moment the two laminated rings as electrical mains and the tie bars as translating devices. Then, if the two mains be of low and the translating devices of high resistance, the current through the translating devices will be substantially independent of the points of attachment of the feeders—the analogues of the inductor poles. Similarly, if the reluctance in the direction of the lamination be low in comparison with that in the direction of the tie bars, the magnetic flux in each bar will be constant, no matter what the position of the inductor poles. In this manner, the change of flux is confined to a small portion of the armature iron, which may be thoroughly laminated, and thus Foucault-current losses are suppressed and hysteresis losses reduced to a minimum. It thus becomes possible to use in the armature any quantity and form of iron demanded for structural reasons.

It will be noticed that the inductor poles are curved in a special manner. This is done to make the electromotive force curve as nearly as possible a sine curve. You will remember that some time ago much space was given up in the electrical journals to a controversy as to the best form of electromotive force wave. Nearly every form of wave found some advocate for some purpose, but somehow the sine wave seemed always to be second best. As we are building machines for general service, we are entirely satisfied with that curve which is second best for each special purpose, believing it to be in consequence the best for general distribution work.

The heavy copper bobbin surrounding the exciting coil, besides being a mechanical protection for the coil, is also of use in that it prevents the development of an excessive electromotive force in either exciting or induced coils, if the exciting circuit should be accidentally broken. It resists very powerfully any sudden change of flux.

An important advantage of all stationary induced-coil machines, and, of course, therefore, of inductors, is the possibility of regulating separate circuits or feeders with little or no auxiliary apparatus. Since it is possible to tap the armature coils at any point, any desired electromotive force between zero and the maximum may be obtained for one circuit without altering the excitation, and, consequently, without interfering with the electromotive force of any other circuit. Circuits or feeders having different drops may thus be provided for. Figs. 28 and 29 show two methods of operation. The coils, AA, in the first are the main inducing coils, giving the electromotive force necessary for all circuits or for the mains in a feeder and main system. BB are the auxiliary or regulating coils. The number of the regulating coils in circuit is controlled by the switches, CC. The diagram shows only two circuits; but, of course, any number may be branched on, each with its own regulating switch. This method is the simpler for the operation of only one or two machines. With a larger number of machines I would recommend the method shown in Fig. 29, as it gives simpler switch connections. In this method, the auxiliary induced coils do not act directly upon the circuits, but only through the intermediary of the auto-converters, D. This method of regulation has the advantage over the ordinary "booster" system that the auto-converter, D, for the same regulation needs to be only one-half the size of the corresponding "booster," and it is, besides, more efficient. The adoption of either method secures the same flexibility and ease of control of

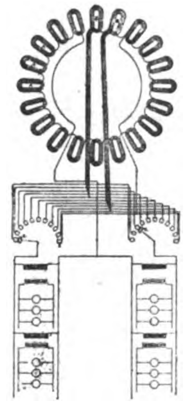


FIG. 28.

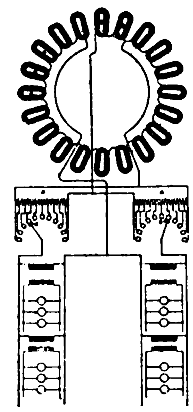


FIG. 29.

the individual circuits as if a separate machine were used to feed each one, while, at the same time, we get the lower first cost and greater economy of operation of large machines.

THE NIAGARA CALCIUM CARBIDE PLANT.

BY ORRIN E. DUNLAP.

THE calcium carbide plant at Niagara Falls is now in operation. This plant is the property of the Acetylene Light, Heat and Power Company, of Philadelphia, and is the first plant of its kind erected in America for commercial purposes. The start was made on April 27. Mr. J. M. Morehead, chief engineer of the Electro-Gas Company, superintended the erection of the plant.

The company claim that they can make carbide for less than $23 per ton of 2,000 pounds, and that this will be improved on. At present a record is made and kept of everything done at the plant, so that in course of time Vice-President Vincent, who is in charge, will have fully accurate data as a basis for computation.

As originally erected the factory was 40 x 90 feet at the foundation. The structure is of brick, the front portion being two stories high. To this building a brick addition 30 x 60 feet has been added to that part which is one story high. Other extensions are in contemplation. The front, or two-story, part of the building is devoted to the crushing and grinding plant, of 50 tons capacity. In the rear of this is the furnace room, containing four furnaces, and adjoining the furnace room on the lower floor is the transformer room. Beyond the furnace room is the storeroom. The laboratory is upstairs; the office on the lower floor. The president of the company, Mr. C. C. Adams, has stated that a continuous furnace is to be added to the plant, the present furnaces not being of that description. This, of course, would be a material factor in lessening the cost of the production of carbide, about which there is so much dispute at present.

The Niagara furnaces shown in the engraving, Fig. 1, each contain a cast iron crucible 3 feet 6 inches long, 2 feet 8 inches deep, and 2 feet 2 inches wide. The electric furnace consists of a horizontal bedplate, or crucible, connected to one

pole of the generator or transformer, and of a vertical carbon pencil connected to the other pole, suspended above the center of the bedplate and capable of moving in a vertical direction.

In starting a furnace in operation the carbon pencil is momentarily placed in contact with the bedplate. The carbon pencil is then raised, imposing an air gap in the circuit. Having established the arc in this manner, the material is fed in towards the crucible, or bedplate, covering the arc and surrounding the pencil to a depth of from two to three feet. The production of carbide begins immediately. The carbide thus

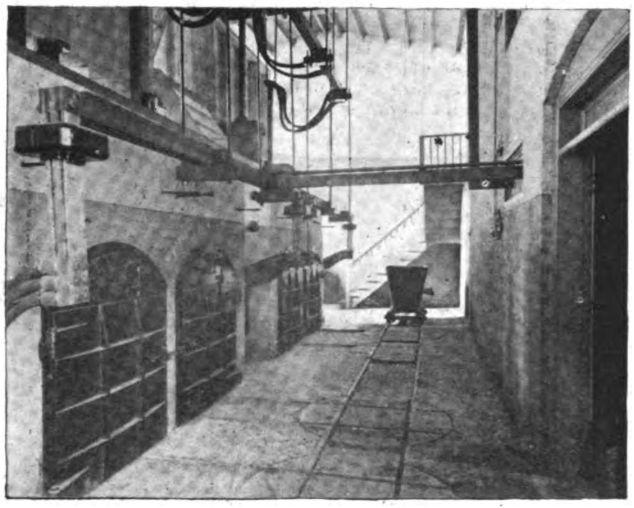


FIG. I.—ELECTRIC FURNACES IN THE CARBIDE PLANT, NIAGARA FALLS.

produced forms under the pencil and tends to close the air gap. As the air gap is shortened the resistance of the furnace is lowered and the load increases, which is shown by the ammeter. The attendant in charge then raises the pencil so as to lengthen the air gap, increasing the resistance and lowering the load to its normal amount. This adjustment is necessary every few minutes. One man can attend four furnaces. In the installation an ammeter showing the flow of current to each furnace is placed in immediate proximity to the carbon-raising device, which controls the carbon for that furnace.

After the process has been going on in this manner for

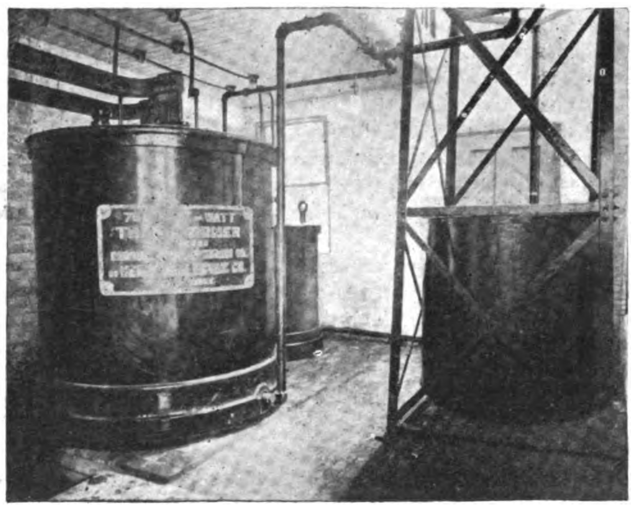


FIG. 2.—750 K. W. TRANSFORMER, CARBIDE PLANT, NIAGARA FALLS.

from one to three hours, a column of carbide from one to four feet in diameter is formed between the bedplate and the bottom of the carbon pencil, the arc being maintained between the top of the column of carbide and the bottom of the pencil. As the carbide formed has a comparatively high electrical resistance, and as this remains in circuit after it is formed, it is economical to stop the process, clear out the crucible and make a new start, after a column of two to six feet—according to the capacity of the furnace—has been produced. The process of drawing a charge consumes from three to five minutes. The carbide is then allowed to cool, after which it is broken up and may be stored for any length of time.

Each of the furnaces at Niagara is designed to consume 500 horse-power. The bedplate in the furnaces at Niagara consists of a cast iron crucible placed on a car, which is run into the furnace on a track under the carbon pencil. A clamping device makes the necessary electrical contact on the side of the crucible. The "pencils" consist of six carbon slabs 46 inches long, 4 inches thick, 8 inches wide, at lower end, and 16 inches wide at the upper. These are clamped in a cast iron holder, which in turn is secured to the end of a copper rod 3½ by 3½ inches. Flexible copper cables are fastened into the upper end of this rod to permit of a vertical movement of about 12 feet. The carbon pencils, the carbon holder, and the rod are all counterpoised to lessen the work and facilitate the raising and lowering of the upper electrode. After the arc is started the mixed material is fed into the crucible by opening the chute and allowing it to drop in from a bin located above the furnaces.

The furnaces at Niagara, for the present, are wired in parallel and two are in operation at the same time. Some dioxide of carbon is produced during the process and this carries out of the furnace, mechanically, a small portion of the lime and coke. To provide a settling chamber in which this can be recovered a flue 12 feet long, with hanging walls and diaphragm, is built back of the furnaces and along the floor to a vent at some convenient point. Each furnace, consuming 500 horse-power, it is asserted, will produce in one day about 2½ tons of carbide.

The electrical equipment of the plant at Niagara consists of one 1,000 horse-power single-phase transformer and a reactive coil to be used in starting the furnaces, to prevent an overload on the generators; these are shown in the engraving, Fig. 2. There is also a 75 horse-power, two-phase, 2,000 volt motor used for operating the crushing, grinding and mixing machines, elevator and conveyors.

HIGH VOLTAGE LAMPS AND THEIR INFLUENCE IN CENTRAL STATION PRACTICE.—V.

BY G. L. ADDENBROOKE, M. I. E. E.

(Concluded.)

IT may be useful here to give a few general data relating to accumulators as they stand at present. The leading makers' prices of central station batteries work out at about £13 per kilowatt on a discharge for three hours, for the plates, cells and acid only; while, including stands, erection, connections and switching arrangements, the price works out about £17 per kilowatt, or, if buildings also are included, about £19 per kilowatt. In such a battery, I find the plates and lead cells alone would weigh about 8 cwt. per kilowatt output on the three hours' discharge basis; and that 1 cwt. of plates and cells costs a little under £2—or the cost comes to about £40 per ton. Now, as lead costs under £12 per ton at present, and seeing how much almost pure lead, in a very simple form, there is in accumulators, it does not seem unreasonable to anticipate that in the future, when accumulators are made on a much larger scale, we may see the price gradually come down to, say, £25 per ton, with, perhaps improved capacity and life. At least, it appears to me that there is as good hope in this direction as there is of reduction in price and improvement in quality in any other department of electrical engineering. If such a consummation were attained, it is pretty clear that it might pay to use accumulators for power stations, as well as lighting, wherever an eight or nine hours' day was in vogue, and that they may ultimately come to exercise a much wider influence on the future of the electric industry than most engineers have anticipated.

In order to gauge in some measure what has been the improvement in accumulators during the last few years, and since the question of the system of central-station supply was last prominently before this institution, I lately took an opportunity of talking the matter over with Mr. Epstein, and I asked him if by looking up old contracts and catalogues he could give anything definite on the subject; in reply, he has sent me the following letter: "I have looked into the question of the prices of accumulators, and I find that, comparing the prices of 1890 with the present ones, there is, on an average, a reduction of 25 per cent. But another and more important point is this—that whereas the types then manufactured were only allowed to be discharged in about ten hours, necessitating in the case of shorter discharges much larger batteries than required for the purpose, the discharge rate has since then increased very considerably. Taking one with the other, I think I am justified in saying that the reduction altogether amounts to quite 50 per cent." In view of these facts, and considering that it is now the custom to buy accumulators on a moderate maintenance agreement, and also all the added experience of

the last five years' work, it will be at once evident on how much sounder a basis commercially accumulators now rest, and how much stronger the arguments in favor of their employment in central stations are than they formerly were.

Upon the three hours' discharge basis, I find a kilowatt capacity of accumulators occupies approximately 4 cubic feet space, for the cells and connections, so that we get a kilowatt-hour into 1.33 cubic feet. Now a discharge of a kilowatt-hour, allowing for losses, will keep about fifteen 16 candle-power lamps going for one hour. Allowing that a gas burner using 6 feet of gas per hour is equal to a 16 candle-power lamp, the amount of space needed in a gasometer to store gas for the same amount of light is $6 \times 15 = 90$ cubic feet, or 70 times as much space. Of course, this is not quite a fair comparison, because nothing is allowed for stands, access, etc.; but I think it will be quite fair if we allow ten times as much space for access, etc., as the accumulators take themselves. Even under these, the actual conditions, accumulators only occupy one-seventh the space which the equivalent gasometer would. We arrive, therefore, at the curious conclusion that, if the London gasometers were emptied of their gas and fitted up as accumulator rooms, sufficient accumulators for lighting London could easily be arranged under working conditions in one-seventh of the space which would be available. We have, therefore, nothing very enormous to fear in the way of accumulator houses, even if accumulators are used in the future on the most extensive scale for lighting and power purposes.

Interesting as these speculations are, it is desirable, however, to return to what is more specifically our subject. It is usual at present to place the accumulators in the central station, except in a few instances, such as in Mr. King's system at Chelsea, Mr. Parker's Oxford system, and a few special places. Usually under these circumstances the accumulator is subject to the heavy drop at full load, which decreases its efficiency by 10 to 15 per cent. With 20 volt lamps the drop on the feeders within a mile radius would be much less than is usual now, and therefore the value of the accumulators would be correspondingly increased. For longer distances from central stations than a mile, however, undoubtedly the right place in most cases for accumulators will be at the feeder points. This is the more feasible with 220 volt lamps than under present practice, because the distributing network is so much larger from each feeder, and each feeder becomes the center of a serious amount of lighting, which will pay for individual attention. Although from the table I have given the cost of copper per lamp installed for feeders is very moderate, yet on a two-mile feeder it amounts to a considerable sum in the aggregate, and if, by installing accumulators at the end of the feeder for one-third to half the full output, the section of the feeder can be cut down by one-third or a half, a very important saving is effected; and, of course, if accumulators for two-thirds or three-fourths full load were installed, the cost of feeders would be correspondingly reduced. This has already been recognized in practice, and many devices have been brought out for charging accumulators in series, or by the help of motor transformers using a high-tension current; but I would point out that the use of 220 volt lamps on a three-wire system does away with the necessity for any of these complications. All that is needed is a continuous-current motor transformer of the "booster" type. In this, one armature circuit is across the mains, and wound with a high resistance and many turns, while the current to the accumulators passes through the second circuit direct; the second circuit being wound with a few turns, so that the voltage of the main current in passing through the armature is raised, say, 30 per cent. The motor transformer then need only be about one-third the capacity for the charging current, and the cells can be charged at any time, while the circuit is supplying lamps, so that continuity of supply without complication is ensured. By these means the cost of long feeders would be much reduced on the figures given above; which means also that it would be practicable to extend the lighting radius much further than was contemplated above at the same cost, should it be needed. An important factor is also brought in—that, having once laid a feeder of fair size, accumulators can be added at the outer end as the lighting grows, and thus a very large increase of lighting could be gradually met without relaying the feeder or disturbing the streets, which is always an expensive and troublesome operation.

In what I have said above I have indicated a feeder to each half square mile as an average, or four to the square mile; but it is clear that, if accumulators were employed, and it were desirable to concentrate them in order to save labor and attendance, it would be very simple to run short sub-feeders from a center, so that one distributing point where accumulators were situated, and one feeder from the central station, could be economically made to serve a square mile or more.

It is further worth noting that at 220 volts the cutting in or out of a cell makes less than 1 per cent. difference in the voltage, and not 2 per cent., as at present. This is an important consideration in keeping the light steady, a point the importance of which is becoming more and more recognized.

The convenience of the system for arc lighting does not need pointing out, as nine arc lamps can be run in series. One more point is the effect which a general electric supply at 220 volts on the lines indicated above would have on the power supply question. There is no difficulty in procuring already motors of any size, from 50 watts upward, to run on 220 volt circuits, the number of amperes they take being, of course, half what is usual now; while for larger sizes, say, above 3 or 4 kilowatts, they could, of course, be coupled across the two outers at 440 volts. If we then add the facts that the drop on the feeders would be less than at present, that the current density in the distributing system on the basis I have laid down would only be about half what it is at present—and when we consider that there would only be 1½ per cent. fall of pressure at full load on the distributing mains, and that by cross-coupling even this would be reduced—then it seems to me that it goes almost without saying that motors could be used to a far greater extent than at present is possible without appreciably affecting the regularity of the lighting. Accumulators at the feeding points would also be an important aid in this respect; if they were so used, the fall of voltage from them to the motors would rarely exceed 2 per cent., and under such circumstances motors of considerable size could be started and stopped (even without special starting resistances) without the rush of current being perceptible on neighboring lamps. In this respect, therefore, the use of 220 volts is likely to be very advantageous, and do away with the necessity of having to lay special power mains—for some years, at any rate.

The utility of having generators in the lighting stations giving the current and voltage which is needed for tramway work is also obvious; in fact, it looks as if one station in future would do all the power supply for a town, the lighting being only one adjunct of its business, and that, possibly, not the largest. With most of the lighting done by means of accumulators charged during the night, and the station supplying power to the tramways, etc., during the day, it ought to be possible to secure a very fairly even all-day load with one set of plant, instead of two as at present. This would, of course, lead to important economies in generating expenses. In fact, it looks as if we could already see far enough ahead practically to enable Mr. Preece's prophecy to be fulfilled in a moderate time—"that the electric light would ultimately be the light of the poor man as well as of the rich."

And now I must conclude. The title of my paper was "High-Voltage Lamps, and their Influence on Central Station Practice." In the first place, I have endeavored to show that high-voltage lamps are thoroughly practical. Next, that high-voltage lamps are more desirable than lamps of the usual voltage and of high economy. I have also shown reasons why it is probable that the economy of high-voltage lamps may in time nearly approach that obtainable in ordinary voltage lamps.

Having thus tried to establish the soundness of the position of the high-voltage lamp itself, I went on to consider what influence the adoption of a high-voltage lamp would have on central station practice. I have shown how it simplifies and renders less costly the distribution of current, and how it improves the conditions of lighting. I think I have further made it fairly clear that for nearly all practical requirements of town lighting the direct supply system will prove simpler and less costly, as well as more advantageous, than any system, whether direct or alternating, in which transformers are used; in fact, the necessity for this class of apparatus, except for special cases, seems to vanish.

I think, therefore, that when the facts are fairly faced, there does not seem much doubt that those engineers who have advised their clients to erect continuous-current direct supply stations in the past have done wisely, and will be found to have served their clients' best interests; and that for the future alternating-current stations, even for country towns and scattered districts, should only be erected after the most careful weighing of possibilities.

It is considerations of this character which have led me to keep very much in the background as regards central station lighting for the last four years. Having been associated from the early days with alternating currents, my predilections were in that direction; and although the position seemed secure, yet, seeing the possibility of great improvements in several directions which would tell strongly in the favor of direct supply (but the exact advent of which no one could actually foretell until it arrived), it seemed to me more prudent to turn one's attention to other things for the time than to incur the risk of recommending work which might soon have to be undone. I have always expected and looked forward to a time when there would be one system of lighting, with varia-

tions merely in details, and have felt that the rivalry between the two systems would some day end as the battle of the gauges ended in the early railway days, and I think there are signs of the end now. It seems as if the narrow gauge would win again—as if the tortoise would again beat the hare, though it is true that to do so the tortoise has had to improve its pace considerably.

REPORT OF COMMITTEE ON DATA.[1]

Your committee is able to present a tabulated statement of watt-hours produced per pound of coal from 82 central stations using coal as fuel, and from one using crude oil, and are able to show the class of equipment from all, boiler tests from 32, and engine efficiency from 8. So far the work has been carried forward on the lines of the previous reports by this committee. In addition to this, we have been able, from the information furnished, to construct load lines from 22 of the stations reported, the lines being presented on Charts 1, 2 and 3, submitted herewith, each line being numbered to correspond with the number of the report. Economies are given from a number of the largest electric stations in the country, 5 of them

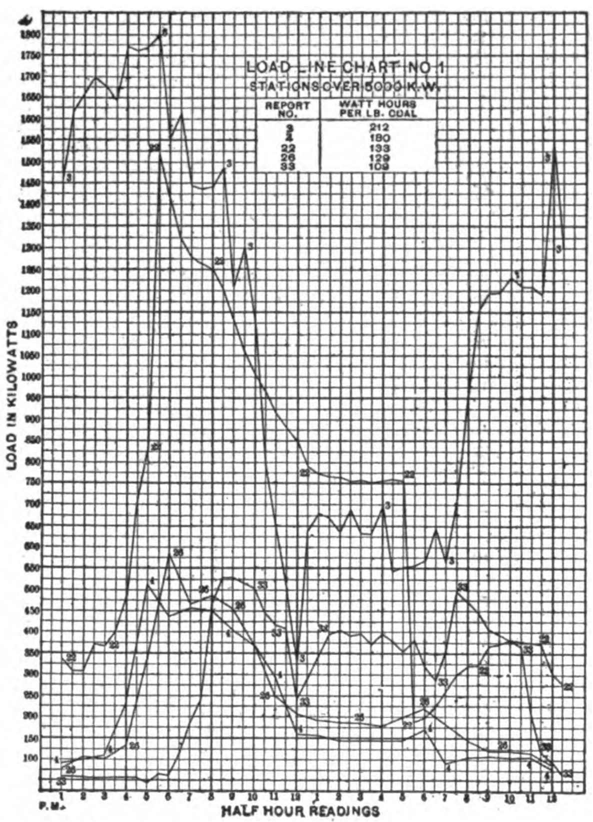


CHART No. 1.

having an output of over 10,000,000 watt-hours per day, and 45 having an output of 1 to 10 million watt-hours per day. Four of the large stations represent a production of 94,270 kilowatt-hours and a consumption of 524,667 pounds of coal, or 179 watt-hours per pound of coal. The aggregate output of these 49 large stations reaches the production of 212,617 kilowatt-hours in one day at an expense of 1,316,703 pounds of coal, or an average of 161 watt-hours per pound of coal. The aggregate output of 32 smaller stations, those producing less than 1 million watt-hours per day, represents a production of 11,973 kilowatt-hours with an expenditure of 194,274 pounds of coal, or 62 watt-hours per pound of coal. The aggregate electrical output of entire report, several stations having reported for a long period, in one case (Report 6) for one year, represents the generation of 4,618,976 kilowatt-hours at an expense of 28,-274,536 pounds of coal, or an average of 164 watt-hours per pound of coal. The average efficiency of the 81 reports using coal as fuel is 108 watt-hours per pound of coal; one report giving the production from crude oil shows 1,717 watt-hours per gallon of oil.

[1]Presented at the N. E. L. A. Convention New York, May 5-7, 1896.

The load lines shown in the charts have been constructed from thirty-minute readings from meters or estimated from voltage and amperes. The committee realize that in the case of alternating currents the product of amperes times volts may

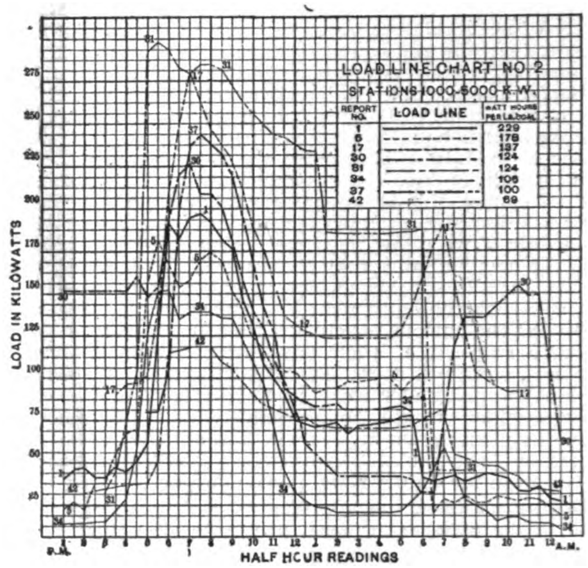


CHART No. 2.

not give the absolute watts, but this method has been considered sufficiently accurate for this work, and has been used in a few instances. The minor points called for in the information blank sent out by the committee relative to evaporation per pound of coal, water used in the engines, calorimeter tests, etc., have not received very general attention, although simple directions were given for this work. The 31 stations

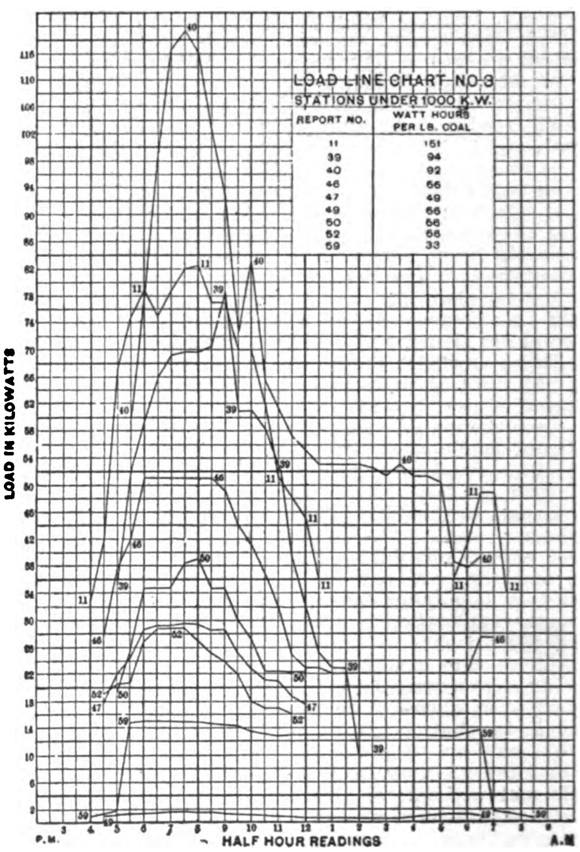


CHART No. 3.

reporting the water evaporated per pound of coal show a wide range of boiler efficiency not to be accounted for by the difference in quality of fuel. Report No. 81 evaporates 10.5 pounds of water per pound of semi-bituminous coal, comparing fav-

orably with report No. 8, each using horizontal tubular boilers; while report 67 evaporates only 4.66 pounds of water per reports being 7.09. In engine efficiency 8 stations report the water consumption per indicated horse-power. The triple ex-

TABULATED REPORT FROM ELECTRIC LIGHT STATIONS; SHOWING WATTS PER POUND OF FUEL, EQUIPMENT, EFFICIENCY, ETC.

No. of Report	Hours in Run.	Watt Hours One Day.	Coal Used, One Day, Lbs.	Watt Hours Per Lb. Coal.	Fuel—Kind and Grade.	Equipment. (See Foot Notes.) Engines.	Boilers.	Dynamos.	Boiler Test. Evaporation. Per Lb. Coal.	Per Lb. Combustible. Actual.	From and at 212°	Engine Test. Water per Hour per I H. P.	No. of Report
1	24	3207392	11600	237	Bit. Lump.	D	C	V	6.2	6.87	7.12	....	1
2	24	2397712	11251	213	Bit. Lump. [Screenings.	D	C	V	5.7	6.45	6.69	....	2
3[1]	24	26402256	124383	212	½ Ea. Soft Coal and Hard	A	A	A	7.38	8.81	10.22	18.	3[1]
4[1]	24	5053166	28050	180	½ Anth. ½ Pea and Dust.	B	1A, 5C	B	8.91	....	....	36.9	4[1]
5[2]	24	1818780	10200	178	.4 Coke .6 Coal.	CD	C	V	5.04	5.75	6.41	27.6	5[2]
6	24	11488509	65884	174[4]	Bit. Run of Mine.	BDz	C	V	....	....	...	....	6
7	24	1212900	7105	171	" " "	B	C	V	....	....	....	....	7
8	24	825000	5022	164	Bit. and Hard Screenings.	Ex	C	V	10.35	11.48	....	....	8
9	24	4270077	26600	161	½ Anth. ½ Dust and Pea.	B	1A, 5C	V	9.17	....	....	42.2	9
10	14	1718000	11400	151	Bit. Va.	BC	C	V	....	....	...	....	10
11[3]	15½	8600	5500	151	" "	CD	A	Alt.	....	....	....	....	11[3]
12	24	2156000	14493	149	Buckwheat.	3C, 1E	C	Alt.	8.99	10.34	11.23	....	12
13	14	1625000	11440	142	Bit.	BC	C	V	....	....	....	....	13
14	16½	711720	5100	140	Bit. Slack.	D	C	V	....	....	....	....	14
15	16½	727720	5200	140	Bit.	D	C	V	....	....	....	....	15
16	14	1624000	11840	137	Bit. Run of Mine.	BC	C	V	....	....	....	....	16
17[2]	14	2734978	19900	137	Slack.	Dx	B	V	8.25	8.9	9.43	....	17[2]
18	14	2599705	19050	136	Slack.	Dx	B	V	7.92	9.35	9.9	....	18
19	14	1526000	11200	136	Bit. Run of Mine.	BC	C	V	....	....	....	....	19
20	14	1560000	11600	134	" " "	BC	C	V	....	....	....	....	20
21	14	2722463	20650	134	Slack.	Dx	B	V	7.08	8.8	9.39	....	21
22[1]	24	16149010	121400	133	Slack and Bit.	B	C	V	....	....	....	....	22[1]
23	16	1528100	11595	131	Bit. Lump.	D	C	V	....	....	....	....	23
24	15½	695720	5300	131	Bit.	D	C	V	....	....	....	....	24
25	16	1549100	11860	131	Bit. Run of Mine.	B	C	V	7.7	8 3	....	....	25
26[1]	24	5401900	41924	129	Semi-Bit.	EDx	BC	..	9.5	12.2	....	30	26[1]
27	14	1399000	11200	126	Bit.	BC	C	V	....	....	....	....	27
28	16	1568600	12000	131	Bit. Lump.	B	C	V	7.7	8.3	....	....	28
29	13	2103800	16800	125	Anth. Buckwheat.	Cx	C	C	6.84	8.26	8.73	26	29
30[2]	24	2683008	21571	124	Bit. Nut and Slack.	Ex	AC	Bi.P.	....	....	....	....	30[2]
31[2]	17½	3396619	27414	124	....	....	....	..	9.08	9.8	....	....	31[2]
32[2]	24	1763795	15625	113	½ Ea. Bit. and Anth.	EDx	C	B	8.93	10.57	11.02	....	32[2]
33[1]	24	6794304	62504	109	.6 Anth, .4 Bit.	Ex	6C, 5A	BE	....	....	....	....	33[1]
34[2]	24	1193876	10475	108	Anth. Buckwheat.	4C, 1E	C	C	....	....	....	....	34[2]
35	24	1074436	10250	105	" "	4C, 1E	C	C	....	....	....	....	35
36	..	160049988[5]	1533000	104	Bit. Screenings.	BC	AB	..	....	....	....	....	36
37[2]	12½	2202363	22080	100	Lignite, Run of Mine.	BDx	AC	Alt.	4.8	5.2	....	....	37[2]
38	..	288440	3041	95	Bit. " "	Ex	C	C	....	....	....	....	38
39[2]	9½	454058	4831	94	Slack.	D	A	V	....	....	....	....	39[2]
40[3]	13	908720	9812	92	Bellwood Bit.	BDx	A	..	5.1	5.6	5.93	....	40[3]
41	..	268800	2896	92	" "	Ex	C	C	....	....	....	....	41
42[2]	24	1444981	20800	69	Slack.	Ex	BC	BC	6.33	....	....	....	42[2]
43	6½	93541	1365	68	Buckwheat, Anth.	E	C	C	....	....	...	....	43
44	8	230187	3600	64	. ...	Ex	C	B	....	....	....	....	44
45	14¾	310928	5000	62	Bit.	Ex	C	V	....	....	....	....	45
46[3]	15	254745	4520	56	Bit.	Dx	C	C	....	....	....	....	46[3]
47[3]	7½	186412	3810	49	Slack.	Ex	C	B	....	....	....	....	47[3]
48	24	66285375[5]	1160500	57	Bit.	1D, 2Ex	A	C	....	....	....	....	48
49[3]	14	156800	2800	56	Bit. Run of Mine.	Ex	C	C	....	....	....	....	49[3]
50[3]	7½	214485	3900	56	Bit.	Ex	C	B	....	....	....	....	50[3]
51	7½	204135	5600	57	Bit.	Ex	C	B	....	....	....	....	51
52[3]	10	6453491[5]	116000	56	Bit. and Slack.	Cx	C	Alt.	....	....	....	....	52[3]
53	7½	217228	4000	54	Bit.	Ex	C	B	....	....	....	....	53
54	7	221250	4200	53	Bit.	Ex	C	B	....	....	....	....	54
55	7½	186412	3810	49	Slack.	Ex	C	B	....	....	....	....	55
56	7	208585	3900	53	Bit.	Ex	C	B	....	....	....	....	56
57	6	161458	3150	51	Bit.	Ex	C	B	....	....	....	....	57
58	7½	174928	3720	47	Bit.	Ex	C	B	....	....	....	....	58
59[3]	15	203555	6200	33	Anth. Buckwheat.	E	C	V	....	....	....	....	59[3]
60	14	762825	20700	37	Bit. Slack.	Exy	C	V	5.44	....	....	....	60
61	15 ½	806880	19300	42	" "	Exy	C	V	5.78	. .	....	....	61
62	18	1294708	31040	42	" "	Ex	C	V	4.23	....	....	....	62
63	16 ½	866235	20500	42	" "	Exy	C	V	5.75	....	....	....	63
64	14	1454656	31739	46	Bit. No. 2 Nut.	Cx	B	V	5.48	6.5	6.85	....	64
65	14 ½	1881102	31992	59	" "	Cx	B	V	5.8	7.1	7.48	....	65
66	24	194472	3300	65	Wilmington Lump.	(1E, 7C) x	C	C	....	....	....	....	66
67	8	444133	6101	73	Bit. Slack.	Ex	C	V	4.66	....	....	....	67
68	14	1201483	15386	78	Bit.	C	C	Alt.	....	....	....	....	68
69	10	506697	6296	80	Bit. Slack.	Ex	C	V	5.59	....	....	....	69
70	24	5962000	71000	84	Bit. Screenings.	(6D1E5Dz)x	A	V	....	....	....	....	70
71	14½	1243441	14224	87	Bit.	C	C	Alt.	....	....	....	....	71
72	14	477425	5400	88	Semi-Bit.	Ex	C	Alt.	9.68	10.7	11.13	37	72
73	24	2879000	31200	92	Bit. Screenings.	Dxz	A	A	....	....	....	....	73
74	13½	1217000	12895	94	Anth.	Ex	C	V	....	....	....	....	74
75	24	1960973	17600	111	Bit.	Ex	C	V	....	....	....	....	75
76	24	3366065	20300	166	½ Ea. Anth. Bit.	B	A	Alt.	6.82	7.89	9 20	....	76
77	24	3373305	20300	166	" "	B	A	Alt.	6.2	7.14	8.83	....	77
78	24	3398595	20300	167	" "	B	A	Alt.	6.6	7.56	8.82	....	78
79	24	40230300	213000	189	Bit. Screenings.	A	A	A	....	....	....	15½	79
80	24	14941089	8700 gals	1717[6]	Crude Petroleum.	D	2B, 1C	B	....	....	....	....	80
81	24	3455988	19100	181	Semi-Bit.	(A.D.E)xy	C	V	10.5	....	....	....	81
82	24	5761915	40800	141	3 Slack 1 Nut.	1D, 2B	B	V	....	....	....	....	82

NOTES.—1, 2, 3; See Load Line Chart 1, 2 or 3, the load line bearing the same [number as report.
4; Average from one year's record.
5; Total for one month.
6; Per gallon of oil.

Equipment Letters denote classes as follows:

A. Engines, triple expansion condensing. Boilers, horizontal water tube. Dynamos, multipolar on engine shaft.
B. Engines, Corliss compound condensing. Boilers, vertical water tube. Dynamos, bipolar, belted from jack shaft.
C. Engines, simple Corliss, or slow speed condensing. Boilers, horizontal tubular. Dynamos, continuous current.
D. Engines, high speed compound condensing, belted direct to dynamo.
E. Engines, simple high speed condensing, belted direct to dynamo,
x. Any of the above non-condensing.
y. Belted to dynamos.
z. Dynamo on engine shaft.

pound of bituminous coal with the same style of boilers. The average evaporation per pound of coal from all stations giving pansions lead in economy, report 80 showing a consumption of 15½ pounds, and report 3 showing 18 pounds of water per

indicated horse-power; these comparing reasonably with report 29 where an indicated horse-power is produced by non-condensing engines with 26 pounds of water. Report No. 22 in the Table of Economies submitted at the last convention, showing a production of 262 watts per pound of coal, and having the highest economy in the stations mentioned in that report, is from the same station as report No. 3 in the present table, and which in point of economy stands third on the last, the economy being 212 watts per pound of coal, a showing somewhat inferior to the previous report. The station is reported in a general way as running at greater economy than when the previous report was made. The efficiency figures, however, would seem to contradict this statement and to verify the statement in the present report. In the previous report, 9.37 pounds of water were evaporated per pound of combustible and 17 pounds of water consumed in the engines per horse-power. The present report brings the evaporation per pound of combustible down to 8.81 pounds of water, and the steam consumption in the engines is raised to 18 pounds, which would account for the lower efficiency stated in the present report.

Attention is called to the reports from plants running with non-condensing engines, in which report 26 (see load line) is able to show 129 watt-hours per pound of coal; report 32 (see load line), 113 watt-hours; report 33, 109 watt-hours; report 37 (see load line), 100 watt-hours, and report 38, 95 watt-hours. While Nos. 39 (see load line), 43, 59 (see load line), 68 and 71 running condensing produce respectively only 94, 68, 33, 78 and 87 watt-hours; this showing and other features in the report proving conclusively that it is as much a question of management and manipulation as of the type of machinery used.

In conclusion, we are led to repeat a former statement by this committee that the economy secured in generating power for electrical work does not compare favorably with the production of power for other purposes, and that this is also true after taking into consideration the variation in load due to electrical work. Referring to a recent statement of the economy of the Chestnut Hill pumping station, at Boston, it was found that in actual water lifted a horse-power was produced by the consumption of 1.34 pounds of coal; allowing that the efficiency of pumps compares favorably with efficiency of the generators, and making no allowance for variation in load, one pound of anthracite coal used with the same economy in electrical work should produce 557 watt-hours. Our load line charts show a fair average of the variation in electrical work, line 3, chart 1, dropping from 1,800 kilowatts at 6 p. m. to 250 kilowatts at midnight; yet the changes seem, as generally true in electric lighting, to be fairly uniform, and a station planned with the proper units for the work should operate the much larger percentage of its generating appliances of a fair basis of economy, bringing the record in this work much nearer the standard of efficiency in other lines. We advise more careful records, more frequent tests of all apparatus and a steady application of principles of economy until this record can be made to show more favorable comparison.

EVOLUTION OF INTERIOR CONDUITS FROM THE ELECTRICAL STANDPOINT.[1]—II.

BY LUTHER STIERINGER, M. I. E. E.

The users of conduits having a lining of insulation, in order to be consistent, should place only bare copper conductors within them. There is only one insulated iron tube, however, in use at present in which such a practice is carried out. This is for underground purposes. A recent installation at Niagara Falls is one of the latest examples of this system. The requirement for insulation of interior conductors is five megohms per mile. In view of this, it can hardly be said that a tube is "insulated" in a commercial sense when, if subjected to the tests applied to conductors, it deteriorates to such an extent as to be practically of no value. Such insulation in conduits is, on its face, of no value whatever to the conductor, which for its efficiency must depend entirely on its own insulation.

Although a period of fifteen years has elapsed since the introduction of the incandescent light, it cannot be said that a standard system of wiring, having the elements of permanency to recommend it, has yet been adopted. Cleat, knob, molding, and other makeshift methods, are still resorted to. Similar makeshift practices were in use in the early gas and water installations, such as the placing of the conductors on the outside of walls and ceilings. The concealment and proper placement of such conductors brought about a comprehensive standard of practice that is now nearly universal.

Conduits, when properly devised to protect insulated electric conductors placed within them from mechanical and chemical injury, make such protection absolute, and are accepted by all intelligent architects, engineers and constructors as permanent. Such a conduit, to be practicable, must be a pipe, or tube, of injury-resisting material; as, for instance, iron gas pipe, which has proved its durability in other more hazardous systems of distribution. The cardinal principle covering all conductors is that they must not allow leaks. The insulation on an electrical conductor, if possessing the property of resisting injury and deterioration, might be considered as self-sufficient. No such insulation, however, has been, or is likely to be, developed. There is one other embryo system that may be developed, possessed of sufficiently desirable features to yet become a standard and a rival of the conduit for interior distribution, viz., the solid, or fixed, system, in which the conductors are firmly fixed in position with the insulation in an injury-resisting metal tube, or covering. These can be made of any length, to suit all requirements.

Another form of a solid system is seen in the cable largely in use abroad for underground work. Its lead covering preserves the insulation, and the metal armor prevents mechanical injury. It has been suggested that this cable could be made sufficiently flexible to be installed from outlet to junction and junction to service. There certainly are situations where it can be employed to advantage.

Some years ago what is known as the concentric wiring system was introduced in England, where it is now in extensive use. "In this system the central conductors must be surrounded over their insulation by a metallic sheathing of conductivity equal to or greater than the core." The concentric system has not been employed in this country, although leading electrical engineers have long ago indorsed its practicability and usefulness.

A company recently put on the market an iron tube (gas pipe) with a lining of thin paper impregnated with an insulating compound, claiming for it the same values in insulating that were possessed by thicker paper-lined tubes already marketed, and also claiming the further advantage of a large bore with the same outside diameter of tube. This concern was absorbed by a company manufacturing the heavy paper-lined iron conduit, and since this consolidation the thin-lined tube has disappeared from the market.

An interior electric conduit of steel, thinner than ordinary gas pipe, with brazed seams, is being introduced. It is undoubtedly intended to be lined with paper similar to the iron-pipe conduits now made by several firms. The special advantage claimed for this steel tube is its cheapness. A large amount of similar tube has been in use for various purposes for some time. Experiments are now being made by various parties with steel and mild steel tubes of injury-resisting qualities and in special forms and fittings, with the idea that they can be produced at a cost lower than gas pipe, and, if found necessary, can be coated or lined with insulations of any kind or thickness.

Iron pipe coated with rubber and other compounds has been in more or less general use for gas and water services for many years. These tubes were coated principally for the purpose of preventing oxidation. The present practice in the case of gas and water mains, whether large or small, including all cast iron pipe used in plumbing, is to immerse the same in a hot bath of bituminous material, for the purpose of preventing escape of gases and oxidation. Such a coating in interior conduits would produce a smooth surface which may be of value, and at the same time cheap and serviceable. So far as the insulation of interior electric conduits is concerned, however, dependence must be placed in any and every case on the covering of the conductor, and not on the lining of the conduit. There need be no restriction as to the kind of material from which interior conduits are made, provided they conform to the requirements of perfect protection against mechanical and chemical injury to the conductors. Such protection was urged in 1890 by the National Electric Light Association at the Montreal meeting, and has since been insisted on by the National Board of Fire Underwriters, and still more recently at the conference on the amending of the national code of rules for safe wiring of buildings, held at the headquarters of the American Institute of Electrical Engineers in New York, March 20, 1896. At this conference the consensus of opinion which has been emphatically expressed by several delegates of large experience was tersely summed up by one of the members in the following brief sentences: "The reason for a lining in the interior of iron pipe must be either mechanical or electrical; if it is simply mechanical, it is inexpensive. If the reason is electrical, is it not rather anomalous that, in a city like this, you can have 100 miles of pipe in the street in which the insulated wires lie in a bare grounded tube, whereas the moment you go into a house you must not have it?" These

[1]Read before the N. E. L. A. New York May 5, 6 and 7, 1896.

requirements need only intelligent interpretation and enforcement to secure satisfactory results. As there is no outward pressure on conduits for electric uses, the same can be made in a simpler and less costly manner than the metal tubes now marketed, and yet possess all the requisite injury-resisting qualities. As soon as this fact is appreciated by manufacturers, evolution will produce the same beneficial results in respect to lessening the cost of material as was the case with wrought iron pipe, which has been tremendously cheapened within the past few years through use of improved methods. The adaptability of material to a purpose is well illustrated in the use of iron pipe in the pipe lines from the oil regions to the seaboard, a distance of over 500 miles. These have been in use for many years under enormous pressures, and give perfect satisfaction. On the other hand, all the resources of the United States Government could not provide a masonry conduit that would answer the purposes or stand the tests to which the above mentioned iron-pipe lines are daily subjected.

Professor Silvanus P. Thompson, in his concise and forcible statement made before the Society of Arts, on May 5, 1893, with reference to house wiring, said: "What is wanted is a mode of running the wires and fixing the switches and other accessories, that they shall not only be electric-tight, but shall be water-tight, gas-tight, air-tight, oil-tight, and rat-tight." All of the above requirements, and more, are fulfilled by a properly insulated conductor inclosed in an injury-resisting metal pipe.

In one of the recent installations of one of the large buildings on Broadway, New York, the electrical engineer who made the plans, firmly believing in plain iron pipe, called for it in the specifications submitted to the contractors. The argument used in introducing insulated iron tube, which was afterward installed, was that the insulation did no harm. If this insulation did not cost more than an iron pipe, or a coated iron pipe, that argument might be proper; but the fact is that architects and contractors find it difficult to have their clients agree to this additional expense. If it is not essential, it obviously suggests extravagance in engineering that is not warranted.

It has been said by an eminent engineer: "Proper engineering consists in utilizing no more material than is required to give satisfactory results." Any additional cost may benefit to a large extent those who seek to market their goods at the expense of a business which would have a more rapid growth if unnecessary cost could be avoided. We are all interested in the promotion of what is at once the cheapest and the best.

APPENDIX.

"House Wiring for Electric Light." Patent No. 343,087, granted June 1, 1886, known as Distribution and Control. No suit has ever been brought on this patent, although it has become the standard system of wiring. The company owning the patent has apparently contributed it to public use in order to advance the introduction of its interior conduits.

Extracts from the specification:

"The object in view is to produce a system of wiring houses, vessels, or the interior of other structures for incandescent electric lamps, arranged in multiple arc or multiple series, wherein there will be a complete and independent control and protection of all the circuits, so that they can be separately made and broken for turning on and off the lights, and properly inspected and tested for 'grounds,' cross connections or imperfect insulation or contacts, and so that the danger of injury by the heating of the conductors will be entirely obviated by the protection of both poles of each circuit by fusible safety catches, wherever a smaller conductor branches from a larger one; all this with the smallest possible number of switches and safety catches. The conductors will be of the minimum size and cost, reducing the expense of installation. There will be the minimum number of changes in the size of conductors, so as to simplify greatly the calculations of sizes of conductors and the preparation of proper plans, and to render the work easy of execution by workmen of ordinary intelligence.

"There will be a proper and equal distribution of current upon the conductors and to the lamps, maintaining all the lamps at normal incandescence, practically independent of lamps in other circuits, or divisions of the same circuit, and not taking any conductor unduly or beyond a safe current-carrying limit, and there will be a convenient location of switches and safety catches for the operation of the switches for testing circuits, for repairs and for replacement of safety catches. In general, the System of House Wiring may be stated to be a System of Distribution and Control, as distinguished from the System of Circulation heretofore employed. In the latter system the main conductors are run past all 'outlets' or points where the wires run into fixtures and the branch lamp circuits are taken from the main conductors at all points along their length, and are run by the shortest paths from the outlets to the mains. The general principle of the System of Distribution and Control is to take all branch circuits from each pair of main conductors at one point, and, if necessary, to divide a pair of branch conductors to all sub-branches from the branch conductors at one point, and so on to any extent of sub-division that it may be found desirable to carry the wiring.

"The conductors of each main are protected at the machine or machines or at the street connections (if in a general system), by double pole safety catches, and are controlled by switches which are also preferably double pole, and at each point of departure of branch conductors from the mains or of sub-branches from branches, each circuit is protected by a double pole safety catch, and controlled by a double pole switch, and the several safety catches and switches for each point of departure of branches from the mains or sub-mains or sub-branches, from branches are assembled together.

"The system hertofore employed has many practical disadvantages and defects, which are overcome and obviated by this system of distribution.

"The features of the invention are applicable to house wiring, whether the wires are concealed or are carried along the surface of walls and ceilings, but while exposed work may be done imperfectly and more expensively by a system of circulation, it is practically impossible to do 'concealed' work in this way, and provide accessible switches and safety catches for all the circuits, and hence the invention has special advantages in its application to concealed work."

A careful study of the patent from which these extracts are quoted may furnish useful information to the electrical engineer.

Extract from a paper read by W. J. Jenks, before the World's Fair Insurance Congress, at the World's Columbian Exposition in 1893:

"It is evident that if conductors are to be capable of ready removal for inspection or replacement, they must be so well insulated from each other and from the tube with which they may be surrounded as to resist the tendency to leakage or short circuit which is produced by the pressure of the particular system to which they are applied. Frequently difficulties arise from the disturbance of such tubes by carpenters, masons, gas fitters and other mechanics, who make changes in the surroundings after the tubes have been placed. Is there not a suggestion of a cheap and useful form of conduit for this work in the fact that for ten years or more the metal pipe of fixtures carrying electric lamps have supported and mechanically protected the wires by which these lamps have been fed? We have only to consider how the portion of the interior conduiting system which can be removably inclosed can be extended from the short length, from the lamps back to the service or junction of the interior conductors with the underground or overhead distributing wires, for which extension of the fixture pipes from the ceiling outlet to the point of supply of the building would provide. Can it not be presumed that, if by closing the upper end of the fixture stem with a water-tight plug we have been able for the past ten years to keep the inclosed wires running through that pipe in good condition, so that they have neither short-circuited between themselves nor grounded upon the fixture metal, we can make an entire system of distributing tubes of gas pipes without encountering serious engineering difficulties?"

THE HEATING AND VENTILATING OF THE SIEGEL-COOPER STORE.

In our recent description of the electrical equipment of the great Siegel-Cooper store mention should have been made that the heating and ventilating plant was carried out according to the designs and plans of Mr. A. R. Wolff, consulting engineer.

TROUBLE WITH THE TACOMA CITY PLANT.

Owing apparently to politcs in city affairs, there has been a good deal of trouble recently in the Tacoma city lighting plant, wires being cut and men refusing to work.

A SALT LAKE CITY TRANSMISSION.

President Donnellan, of the Big Cottonwood Power Company, Salt Lake City, has just entertained a large party there to celebrate the near completion of the power-transmission enterprise, planned by Mr. R. M. Jones, the details of which have already appeared in the columns of The Electrical Engineer.

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CONTENTS.

COAL CONSUMPTION IN CENTRAL STATIONS.

FOR several years past the Committee on Data of the National Electric Light Association has submitted its report at the conventions, but notwithstanding the evidently earnest work and desire of the committee to give the association a valuable comparative document, their efforts can hardly be said to have been crowned with success. The blame for this must be laid on shoulders entirely outside of the committee itself and must be brought home directly to the door of central station managers. It is one thing for a committee to send out elaborate blanks to be filled out, and another thing to have these blanks properly filled and returned. It is, indeed, a sad thing to contemplate that, of some 2,700 central stations operating in the United States at the present time, the statistics of only 82 should be available, and that among these barely a score are given in the desired fullness. This is, indeed, a poor showing, and is in itself a sufficient explanation of the reason why so many stations are operating at low economy—the fact being that probably not one station manager in twenty is aware of the manner in which his apparatus is running. Admittedly unsatisfactory as the report is, it, nevertheless, indicates in a small degree what has been accomplished in some of the best stations in the country, and to that extent is of much value as recording standards for other stations to work up to. In glancing over the table one is struck as much by the diversity in the figures of boiler economy, as by that in those of the engines, even in what may be considered large stations, and in which, it may be presumed, competent supervision ought to be provided. In both cases the question of management is probably a large factor in the equation of economy. This is well brought out in the report, which dwells on the fact that in some instances stations running non-condensing are operating at higher economy than those having condensing engines. The committee might have been specific and added that the discrepancy here shown is probably due to the injudicious selection of the size of units, which works more to the disadvantage of the compound than of the simple engine. Regarding the future work of the Committee on Data, we must reluctantly agree with its spokesman at the convention in his expressed view that the results accomplished are not commensurate with the time and trouble spent on the collection and tabulation of the data. A good suggestion, however, was made, namely, that the work be hereafter confined to the collating and analysis of data of a certain number of stations of each type. This plan would limit the size of the undertaking and would still permit of comparisons being made and of the tracing of the causes leading to the results obtained. These test stations would thus, after a period, constitute a set of models, as it were, towards which similarly equipped stations ought to work—or which it would be well to shun.

PUCK'S "FORTY MINUTE" GIRDLE.

NOT until the cable has been laid across the Pacific will the telegraph be able to accomplish Puck's prediction that he would put a girdle round about the earth in forty minutes; but the experts at the National Electrical Exposition came pretty near doing it on Saturday night by sending to Tokio and back and to the tip of South America and back in 47½ and 21 minutes, respectively. It was a great night for the Western Union, Postal and Commercial Cable Companies, and none that saw it will ever forget the spectacle when the salvos of cheers from more than 10,000 people in that brilliant hall lifted Thomas A. Edison to his feet twice to receive their spontaneous and unstinted homage.

THE FEATURE OF THE EXPOSITION.

THERE is one feature of the exposition that must strike all observers in any degree familiar with the electrical situation, and that is, the courage and success with which what are known as the "independent manufacturers" have practically monopolized the show. Leaving out of view the superb exhibit of the local Edison Company, which, of course, includes a great deal of General Electric apparatus, and leaving out also the excellent exhibits of the Brush and Westinghouse Companies, it might fairly be said that the exposition owes its magnitude and importance very largely to the splendid displays of concerns that belong to no trust or combine, but depend upon the merit of their goods for public favor and patronage. In reality this exposition thus indicates the relative degrees of present prosperity and future activity as between the debt-burdened, tottering monopoly and the swarm of numerous energetic companies that are specializing their goods and capturing the market.

It is now recognized that one company after another has gone into the embrace of the General Electric Company simply to be gutted, leaving free for new enterprises a mass of talent and experience which is soon in service for new capital and in its own behalf. Thus a few "inside" stockholders are benefited, but the General Company has won nothing tangible. It is obvious that fifty or sixty millions of capital in the electrical business cannot be kept intact on a turnover of only some fifteen millions a year. Even a turnover equal to the bloated capital would barely pay dividends on it, and who expects ever to see the General Company do half that amount of business?

To be brief, the field belongs to the independent manufacturer, and we know of no power of purse, litigation or strategy that can deprive them of the great and grand market of electrical applications already established or now opening up.

220 VOLT INCANDESCENT LAMPS.

THE discussions at the recent meeting of the National Electric Light Asociation took in a wide range of sugjects, but, as we have had occasion to remark before in referring to the convention, the incandescent lamp was passed over with scarcely a mention. This is all the more to be regretted since recent developments in this field would have furnished an excellent topic for discussion. We refer to the steadily increasing use of 220 volt incandescent lamps. From the results thus far attained, the inference is fair that with the lapse of time their employment will cause the general displacement of the time-honored 110 volt lamp. The effect of the introduction of the high voltage lamp on existing circuits is admirably set forth in the exhaustive paper of Mr. G. L. Addenbrooke, concluded in this week's isue; but, in order to more fully comprehend the nature of the new departure, it may not be amiss to point out the fact that at the same efficiency, a 200 volt lamp must have a filament four times the resistance of a 110 volt lamp, and with the same surface. This means a very long and very thin filament, and such filaments are at once difficult to make and hard to support in the bulb, owing to their great length and lack of stiffness. Regarding the efficiency of such lamps, the fact must not be lost sight of that owing to their extreme thinness, these filaments are much shorter lived than the thicker 110 volt filaments at the same efficiency; and in order to render them commercially useful they are drawn to consume four watts per candle. This lower efficiency makes the filament thicker, besides lowering its temperature of operation. These relations seem bound to exist in lamps made by the present methods, using hydrocarbon treatment, and any improvement which produces a good 3-watt 220 volt lamp will probably make a corresponding improvement in the practical efficiency of the 110 volt lamp. The advantages of 220 volt lamps, from an engineering point of of view, are pretty well recognized; but it seems to us that Mr. Addenbrooke over-estimates them somewhat by basing his calculations on a constant percentage of loss in conductors, which in the example selected by him makes the same size conductor carry twice as much current for 220 volt lamps as for 110 volt lamps. Objections have been raised in some quarters to the introduction of 220 volts into fixtures, but with increasing use and with experience, these will be overcome without doubt. Inquiry develops the fact that during the past year one company alone sold 10,000 240 volt lamps, and that their quality is constantly improving so that as good results are obtained in practice from a 240 volt lamp as from the 3.1 watt, 110 volt lamp.

THE FERTILITY OF ELECTRICAL INVENTORS.

THE fine exhibit of electrical models made by the U. S. Patent Office at the exposition attracts large crowds, while it is no uncommon thing to see well-known engineers and experts hanging over the cases by the hour. Some of them meet with an occasional surprise, as did Mr. Westinghouse, when he came accidentally upon a telephone system which he invented as long ago as 1879. Some people who thought his electrical knowledge of late acquisition are as surprised as he.

But what impresses one in these interesting cases is the fertility of the leading electrical inventors. It has indeed been a glorious field for opportunities of work, and hence the leaders in electricity are likewise the leaders over all. The figures recently compiled by the U. S. Patent Office to show how things stood in this respect, are remarkable. We find Edison credited with 711 patents, taken out at the rate of 28 a year; Elihu Thomson with 394; Edward Weston with 274; C. J. Van Depoele with 244; and C. E. Scribner with 248. These men and their inventions respresent wellnigh all branches of the electrical arts, and are closely followed by others high on the roll of fame.

And yet, as one looks around the show and on the industry at large, one realizes that new big groups of inventions are needed, and that in all probability new names will be associated with them. There is room for the younger men and the triumphs of their seniors should stimulate them.

STEAM AND ELECTRIC LOCOMOTIVES.

NUMEROUS writers have discussed the probabilities of the adoption of electric locomotives on steam railway trunk lines, but all of these discussions have thus far treated the subject in a general way, and no detailed figures have been forthcoming by which a fair judgment might be formed of the real practicability of the proposition. In the articles by Mr. William Baxter, Jr., which have appeared in these columns, that writer has for the first time undertaken to show by direct comparison of item with item the true status of the situation, basing his arguments on the official reports of steam railway companies. In this week's issue Mr. Baxter undertakes to show that in the case of the Pennsylvania Railroad, that company could effect a saving of over $6,700,000, or 16.4 per cent. of its operating expenses, by the adoption of electricity. Some of Mr. Baxter's figures will no doubt call forth criticism among steam railway engineers; but far from seeking to evade them, we know that Mr. Baxter would be pleased to have any such brought forward. A thorough ventilation of the subject will not, we believe, result disadvantageously to electricity.

ELECTRIC TRANSPORTATION.

CAN ELECTRICITY SUPPLANT THE STEAM LOCOMOTIVE ON TRUNK RAILWAYS?—XII.

Wm. Baxter Jr.

THE next item in the cost of operating steam roads that would be reduced by the use of electricity is that of water supply for locomotives. As electric motors do not use water no supply would be required and therefore the whole of this expense could be saved.

The next item in order is that of all other supplies to locomotives, and this includes oil, waste, packing for stuffing boxes, etc. As there are probably twenty times as many parts that require lubrication on a locomotive as on an electric motor, and as some of these parts, such as the cylinders, for example, require a large amount of lubricant, it is quite evident that the amount of oil used to lubricate locomotives would far exceed that required for motors. As to waste the same statement holds good. Locomotives are wiped off every day, but motors not once a week, and then the difference between the amount of surface to be cleaned in both cases is very great. As to packing, there would be none required for electric motors. In view of these facts it will not be unreasonable to cut down this item fully 75 per cent.

Now we come to the two last items, and we will consider them together because the change in methods of operating a road by electricity that would reduce the amount of one would also reduce the other. As will be noticed these two items cover the wages of switchmen, flagmen, watchmen, telegraph operators and train dispatchers, and also other expenses in connection with the telegraph system. We assume that these charges include the cost of operating the signal system, and on that account claim that the amount can be reduced by the adoption of electricity. To effect a reduction in these charges it would be necessary to replace the block system now used by an automatic one, in which the motion of all the motors on the road would be controlled one by the other, in such a manner as to render collisions practically impossible. We have already explained this system in a general way; it is not necessary to go into a detailed description, as several such systems have been devised and some have been worked out so as to meet every possible case that may arise in practice. Therefore it cannot be said that we claim a reduction in the two items under consideration on the supposition that a new and perhaps impracticable system of guarding against accidents would have to be used. It is true that a new system would have to be used, and it is also true that such a system has not yet been proved a practical success by actual trial. But there are some things that are so self-evident that we know they will work perfectly before they are tried and their actual practical operation only serves to demonstrate the fact. This is one of those cases, and no doubt there are hundreds of electrical engineers who have thought out arrangements of this kind.

TABLE 15.

SAVING IN OPERATING EXPENSES OF PENNSYLVANIA RAILROAD BY SUBSTITUTING ELECTRICITY FOR STEAM.

	$	Per cent.	$
Repairs of roadway	2,844,126	20	568,825
Renewals of ties	806,661	20	161,332
Repairs of bridges, etc.............	389,597	5	19,479
Repairs of locomotives	2,896,735	85	2,462,224
Repairs, shop machinery, etc......	149,167	5	7,458
Wages of engineers and firemen...	3,222,974	36[1]	1,147,103
Fuel for locomotives	3,724,481	72*	2,689,713
Water supply for locomotives.....	264,840	100	264,840
All other supplies for locomotives...	236,616	75	177,462
Wages for switchmen, etc..........	1,017,118	5	50,855
Wages of telegraph operators, etc..	1,142,946	5	57,147
Total..................................			$7,606,438

A full description of this system would convince any one at all familiar with the subject that an automatic system such as here proposed is thoroughly practicable, but such a description cannot be given until the rights are properly secured.

What proportion of these two items could be saved by using the system here proposed cannot be determined accurately, as we have no way of ascertaining what portion is directly chargeable to the signaling system; but it is evident that by doing away with all the signal stations pure and simple, that is, those at which there are no switch levers to operate, a very considerable saving could be made. As we are practically without any data upon which to estimate the possible saving, we will make a very moderate claim. We know to a certainty that a saving could be made, and if we can save anything at all it ought to be at least five or ten per cent. We will restrict our claim, however, to the smaller percentage.

We will now summate what could be saved by the substitution of electricity for steam and thus determine whether the total amount is enough to justify the expenditure necessary to provide an electrical equipment.

From the above table we see that the sum total of all the savings that can be made by the adoption of electricity amounts to more than seven and a half millions of dollars, which is over eighteen and a half per cent. of the total operating expenses. This looks like an enormous saving and will no doubt come as a surprise to those who have only counted on making a reduction in the coal bill. It seems almost impossible that such a saving could be made. It may be well, therefore, to look over our reasoning once more and see whether we have assumed a saving in items in which a reduction cannot be reasonably expected.

The first three items, repairs to roadway, renewals of ties, and repair of bridges, may be open to dispute. It may be claimed that no saving could be made in this direction, and although reasoning on correct theoretical principles would lead to the inevitable conclusion that the repairs to the structures would be reduced by the use of electric motors and the consequent elimination of the violent vibrations caused by locomotives, we will concede that there may be room for doubt as to whether the saving would be as large as here claimed. In fact, to see how we will come out by making an extremely conservative estimate, we will admit that nothing can be saved in these items. As to repairs to locomotives we would not be willing to make any such concessions for the very simple reason that, as was clearly shown in the discussion of this question, seventy per cent. of these repairs is on parts that are not used at all in electric motors, and the remaining thirty per cent. is on the machinery of the locomotive. It seems impossible that the wear on the motors should be even as much as one half what it is on the corresponding parts of a locomotive; and that is the relation that was allowed in claiming a reduction of eighty-five per cent. Therefore, we will have to insist, even though willing to make every reasonable concession, that the saving in this item is not any more than practice would bear out.

The repairs to shop machinery and tools is a debatable question and we will therefore strike it out, although there can be no doubt that it would be reduced, from the very fact that there would be less repair work to do. The reduction in wages of firemen could not be changed, as it can be effected if motor cars are used instead of locomotives, and there is no good reason why they should not be used.

The saving in fuel is another item which will not admit of any reduction. A careful consideration of all we have said on that point will show that it has already been made as small as possible. Of the remaining items the only ones in which there is any room for argument are the last two, which cover the wages of switchmen, flagmen, watchmen, telegraph operators, etc. These we can drop out of our claim of savings. Adding together these items that may be conceded to be more or less doubtful we will have:

Repairs to roadway	$568,825.26
Renewal of ties	161,332.38
Repairs of bridges	19,479.89
Repair of shop machinery, etc.........	7,458.35
Wages of switchmen, etc...............	50,855.94
Wages of telegraph operators, etc......	57,147.30
Total	$865,099.12

We thus see that by throwing out entirely those items in which there is room for a reasonable doubt, we still are able to show a saving of $6,741,343.12, which is nearly 16.4 per cent. of the operating expenses.

Inasmuch as we have gone over our figures a second time and have pointed out those items that would be struck out wholly or in part, in an ultra conservative estimate, it is only fair that we should go over them again and see whether there are not some other items in which we could be justified in claiming a saving if we were determined to make the best possible showing for electricity.

[1] Approximately.

In following out this course, if we look at the charges under the heading of maintenance of way and structures, we will find that the cost of renewing rails has not been included in the list of items in which a reduction could be effected. But it will be apparent at once that if the smooth motion of a train drawn by electric motors, and particularly the smooth motion of the motor car itself, will tend to reduce the wear on the roadbed and ties, it will have the same effect on the rails. As a matter of fact it should have, if anything, a greater effect. A locomotive does not move in a straight line parallel with the rails, but follows a wave-line course, due to the side strain caused by the unbalanced condition of the moving parts. This wave motion causes a lateral sliding of the wheels over the rails and thereby increases the wear. This action may not produce very noticeable effects, but, whatever it may amount to, it represents just so much wear that would not be produced by electric motors. It is evident, therefore, that in neglecting to make a reduction in this charge, we have failed to give electricity its full due.

In the matter of maintenance of equipment we have made no claim for a reduction of the cost of repairs of cars, and yet there are several reasons why we should. The more even motion of the motors would produce less strain on the couplings, and, in a measure, on the whole car, and this would necessarily reduce the wear. But this is not the principal cause that would tend to prevent deterioration. The effect of the smoke and cinders on the cars is a factor of considerable importance, especially with passenger cars, on which their action soon produces a dingy appearance, in consequence of which frequent repainting is necessary. This, however, is not all; sometimes the cinders set fire to the cars and in this way considerable damage is done; although this does not happen very often, it is no doubt of sufficiently common occurrence to have a considerable effect on the total cost of repairs.

This brief allusion to some of the causes of wear and tear on cars that are due to the action of the locomotive and would be eliminated by the substitution of electricity will serve to show that, in justice to the latter, we should have made a reduction in this item, but did not do so from a desire to confine our claims to thos charges in which a saving is self-evident and of such a character as to be estimated with a fair degree of accuracy.

Under the head of conducting transportation we find that the largest charge is that for wages of trainmen. We have not claimed that the adoption of electricity would reduce this item, but it undoubtedly would. We may also add that no reduction was made in the wages of enginemen, the reduction in that item being only the wages of firemen. But to be fair we should claim a reduction in wages of enginemen and trainmen. The reasons for this, briefly stated, are, that a motor car could make more miles per day than a locomotive, therefore a smaller number would be required to make the same yearly mileage, and consequently the total wages of enginemen would be reduced. This would be true if the present rates of speed were maintained, but as it would undoubtedly be found that increased speed in all classes of traffic would be more economical, a still further reduction could be made.

As there have been a great many conflicting statements published as to the daily runs of locomotives, and several attempts made by friends of the latter to show that a locomotive can make as great a mileage as an electric motor, it may be well to show just what is done in actual practice.

On the Pennsylvania Railroad there are 1,103 freight engines, and the total miles run by freight trains per year is 20,400,358. It is evident that these locomotives are not in use all the time, as a certain number will always be in the shops undergoing repairs. Assuming that only ninety per cent. are in constant use, we would find that the average number of miles run per year by an engine would be about 20,500. If twenty per cent. of the locomotives are in the repair shop on an average, then the yearly mileage would be about 23,100. In the passenger service there are 478 locomotives, and the total miles run per year by passenger trains is 14,908,800. Figuring on a basis of ninety per cent. of the engines in use, the miles run per year would be 34,670, and on an eighty per cent. basis, 39,000 miles per year.

Trolley cars making an average speed of less than ten miles per hour run from 45,000 to 50,000 miles per year. At this rate motor cars drawing freight trains at 15 miles per hour could easily cover 65,000 to 75,000 miles per year, and those used for passenger work and making an average speed of 30 miles per hour, could run over 100,000 miles per year. Now, if so much greater yearly mileage could be made by electric motors, it follows that the wages of motormen would be very much less than the wages of enginemen per train mile, as the daily compensation would certainly not be any higher, and the miles covered would be much greater. Therefore, from this cause, the reduction in the item of wages of enginemen and firemen would be even greater than we have claimed.

As to trainmen, the reduction in wages per train mile would probably be very small or none at all, if the present rates of speed were maintained; but as has been shown, an increase in speed could be made in all classes of work without any material increase in running expenses. This cannot be done with steam, because the repairs, and especially those on locomotives, increase very fast with augmentation of speed. The reduction in wages of trainmen per mile run would more than make up for any increase in cost of coal and repairs, even for a considerable increase in velocity; therefore, by adopting a somewhat higher speed a considerable saving could be made, and not only that, but with the same equipment, more work could be performed.

In view of all these facts it is evident that our estimate is very conservative and that the results shown could be fully realized in practice.

The saving, as shown, does not represent the net result, as from this amount must be deducted the wages of employés in the power stations and linemen required to keep the trolley lines and feeders in repair. The cost of fuel consumed in stations would not be deducted from this saving, as that has been included in the calculations just made.

We will, in the article to follow, give an estimate of the capacity and cost of installation of an electric equipment for the Pennsylvania road, and in connection with this estimate will show the number of employés required as linemen and stationmen, and the total amount of their wages. We will then be able to show the net difference in cost of operating the roads by steam and electricity, and also the cost of changing to the latter system.

AN UNDERTAKER'S WAGON LIGHTED BY ELECTRICITY.

William J. Tickner & Sons, undertakers, have purchased a novel design in the way of an undertaker's wagon. It was used for the first time a few days ago. The wagon is lighted by electricity by means of a storage battery under the seat. The wagon is drawn by two pure-white horses.

NEWS FROM LOS ANGELES.

The electric road from Los Angeles to Santa Monica Beach, a distance of 20 miles, has been opened for traffic, and upon the following Sunday the company sold several thousand round-trip tickets. It was impossible to accommodate the crowds. People were riding on tops of cars and on trucks, and even standing room was at a premium.

Mr. Herman Laguna, who secured the franchise for the telephone company in Los Angeles some nine months ago, has his agents on the ground contracting for instruments, and claims he will start things a-moving inside of sixty days.

THE BIG B. & O. ELECTRIC LOCOMOTIVES.

The last of the three great electric locomotives for the operation of all trains on the main line of the Baltimore and Ohio Railway has been shipped from the Schenectady works of the General Electric Company. These locomotives will handle the entire freight and passenger traffic of the Baltimore and Ohio Road passing in and out of Baltimore from the north through the Belt Line Tunnel which passes under the city, and which is the longest soft earth tunnel in the world. Each of these locomotives weighs 96 tons, and while almost equal in size to the largest steam locomotives, greatly exceed them in power—that of each equaling nearly 1,500 horse-power. The first was put into service in August last and the second in December, since which date they have been handling the entire freight traffic of the Baltimore and Ohio through the tunnel without accident of any kind.

No limit of speed has yet been reached with these engines. Eighty miles an hour has been attained.

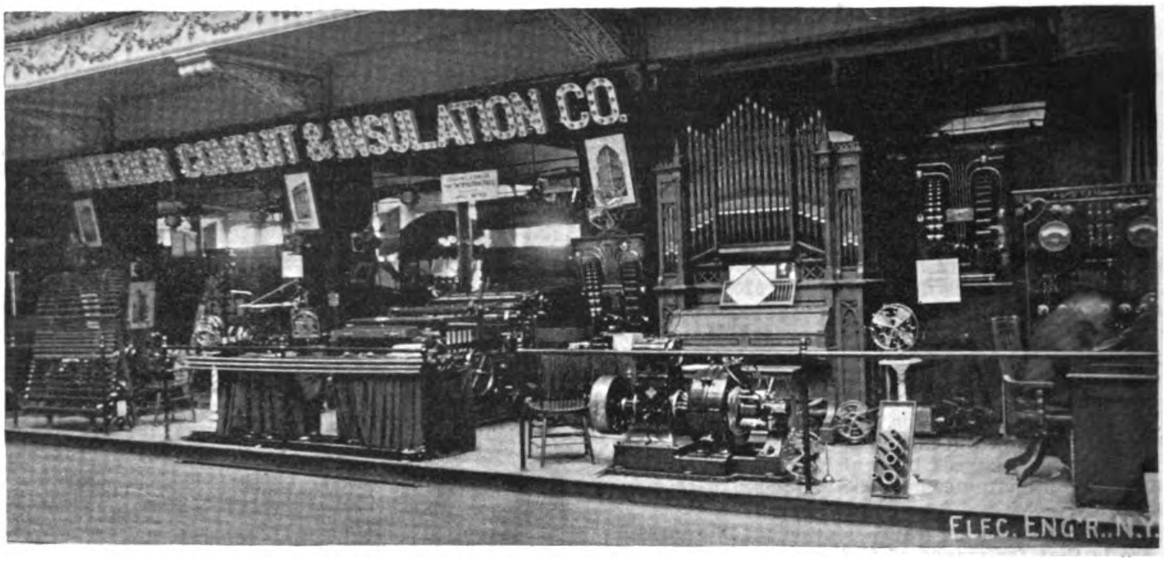
As soon as the third locomotive reaches Baltimore it will be assembled and placed on the tracks. They will then undertake the passenger service as well as the freight traffic, and the present coke-burning engines used with the passenger trains running through the tunnel will be shut off before entering the tunnel.

THE ORDER for the wire for the new electric railway in course of construction between Elgin and Geneva, Ill., has been secured by Holmes, Booth & Hayden, Waterbury, Conn., through their Western agent, Mr. M. B. Austin, the whole amounting in the aggregate to some 125,000 pounds. The Ohio Brass Company have closed the order for the overhead material and tools for the same line through their Chicago agent, Mr. J. H. McGill.

Exhibition Notes—II.

THE INTERIOR CONDUIT AND INSULATION CO.'S REMARKABLE EXHIBIT.

PERHAPS it was not generally realized until this exposition what a remarkable variety of goods and apparatus is turned out by the Interior Conduit and Insulation Company. The space occupied by the Company is almost the whole of Section E, and covers nearly the entire north side of the main hall. It is filled with products that touch all the various branches of the art, and there are few concerns that could begin to make so varied a display. Reflecting credit on the management of the company for its enterprise and energy, the goods tell a remarkable story also of inventive ability and of effective factory skill and vigilance.



THE INTERIOR CONDUIT AND INSULATION CO.'S EXHIBIT AT THE ELECTRICAL EXPOSITION.

It would be difficult to enumerate all the noteworthy appliances and pieces of apparatus included in this extraordinarily fine exhibit. There is, of course, a complete collection of all the types of interior conduit, down to the last, with junction boxes, etc.; and with these are associated many special features such as the interior conduit system adapted to underground work for all classes of wires. Johnson double pole switches are there also, with couplings and other details. It is not to be forgotten that the company had meantime been working out a very successful sectional underground trolley system, in regard to which there are many inquiries made at the show.

Turning to the generating apparatus, we find a direct connected Lundell plant for marine purposes in particular, and driven by a Case engine. Nothing could well be more compact. Then there is a fine display of Lundell motors standing by themselves, and one of them running a small generator of the same general type. A great variety of machinery is in operation driven by Lundell motors, from an S. S. White dental outfit up to a Cottrell printing press. In the central space is a fine one-half manual pedal base Liszt organ with 20 stops, from Mason & Hamlin, operated by the Lundell organ blowing outfit. When Mr. Vandewater, of the company's executive staff, who is a well-known composer and musician, is induced to take the console, a treat is given that delights hundreds of people; while the easy flexibility of the method is clearly shown at the same time.

As for ceiling fans, electrolier fans, desk fans, etc., of the famous Lundell spherical type, their name is legion, for they are not only to be seen within the space, but all over the building, "a boon and a blessing to men." One of these motors has the honor of having been the first to receive Niagara power in New York City. The Western Union circuits were being adjusted and balanced for the Tesla two-phase system, when, in order to ascertain if there was much current on the line, a little Lundell was picked up and hitched on. It was running free, without load, but gave at once unmistakable evidence of the fact that Niagara was literally and actually doing work in New York City, 465 miles away. The motor has been fittingly embellished to commemorate the occasion.

The exhibit is in charge of Mr. Kimber, but Messrs. Johnson, Bakewell, Pease, Lundell and others are all frequently present. They have no reason to be other than very proud of their record at the exposition, and the exhibit must undoubtedly do the company great good.

EXHIBIT OF THE WESTINGHOUSE ELECTRIC MFG. CO.

IT would not have been easy for the Westinghouse Company to have put one of their big Niagara generators on the main floor of the exposition, but they secure just as great an effect with the public by their little Tesla two-phase motor running the Niagara model by Niagara energy. In fact, it may here be said again, that none of the exhibits run to bigness, but are all highly representative.

The current from Niagara for the motor is reduced in pressure at the Falls to about 450 volts and transformed to three-phase by the Scott system. Two Western Union wires and the earth circuit are used, Mr. A. S. Brown, the electrical engineer of the Western Union Telegraph Company, having assisted in the plans and arrangements. The line distance is 465 miles. At the New York end, the voltage is reduced to 12 volts and transformed into two-phase by highly efficient converters.

In order to give the public a clear idea of the action of the Tesla rotating field, a ring of iron has been wound with coils in the two-phase relation. In the strong external rotating fields, copper plated eggs, gyroscopes, rings, discs and other metal bodies are set waltzing in a manner that interests the student and greatly tickles the sensation hunter.

THE WESTINGHOUSE EXHIBIT.

Practical applications of the Tesla two-phase principle are given by several two-phase motors, a Shallenberger meter, and single-phase self-starting motors. Among other things in the space are the new Westinghouse fan motor, a standard switchboard panel, switches, Wurts' lightning arresters, etc. The exhibit is in charge of Mr. Arthur Zimmerman, of New York,

and Mr. Malcolm Maclaren, of Pittsburg, who are indefatigable in their attentions and explanations to visitors. The space is topped by a large handsome red sign with incandescent lamp ornamentation.

THE EXHIBIT OF THE NEW YORK EDISON CO.

UNDER the active and intelligent supervision of Mr. R. R. Bowker himself, the New York Edison Company, over whose affairs he watches so vigilantly, has made an exhibit that evokes admiration from the public and expert electricians alike. It is not large, nor is it small. It is not ornate, but it is very handsome, and its regard for the sense of proportion is very pleasing. It is not a central station, nor is it a bazaar of electrical goods, yet it shows clearly what a central station can do and how the work is done; while at the same time it is surrounded and flanked by adjuncts which bring into proper prominence the various uses to which electricity can be put, ranging from a static machine at one end run by motor, an electrical piano and a cooking outfit, to a printing press at the other end.

THE NEW YORK EDISON ELECTRIC ILLUMINATING CO.'S EXHIBIT.

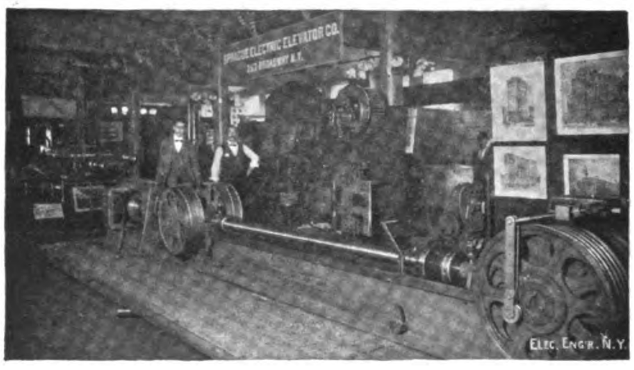
The exhibit lies along the whole southern side of the main hall. As the visitor enters from the stairway, he sees a clever representation in color, on canvas, of the great operating room in the central station at Duane, Elm and Pearl streets. Here are shown, as though in relief against the scenic background, actual sections of the Van Vleck edgewise regulating system, with dynamo switches, regulators, ampere and voltmeters, and with controlling apparatus feeder. Current for this exhibit is supplied to the feeder switchboard from the Edison street mains, and from a storage battery, illustrating the use of such batteries in Edison stations. From this switchboard the current passes through a feeder-tube, such as is used in the city streets, to a feeder-box, thence to a distributing-box, thence through a street main to a service-end box, such as is placed on a consumer's premises. Next the feeder-box is one of the new controllable boxes, by which a tie-feeder can be divided from the station into distributing feeders. From the service-end box, current is carried through an Edison chemical meter, such as is usually placed in a customer's premises (as also through a Thomson wattmeter) and is distributed as it would be in a house, from a distributing switchboard, for its varied applications in lighting (incandescent and arc), power, cooking, heating, etc. Two posts, similar to those on Fifth avenue, show the Edison-Bowker system of street lighting. Electric cooking is shown in practical operation, under the direction of Mrs. Sickels, who gives cooking lessons, as is also electric ironing; and electric heating is exhibited by ordinary radiators, by the "electrotherm" for bedwarming, poulticing, etc., and in other applications.

The power exhibit includes a modern printing press run by Card motor, under the supervision of Mr. R. T. Lozier, without belt or shafting; ventilating fans of various types; surgical and dental machinery; a sewing machine; the electric piano, etc. Elevators run by electric current are shown elsewhere in the building. The center of the exhibit is occupied by the huge curved frame of an upper field of one of the monster 800 k. w. dynamos in the Duane street station. On the map are representations of the principal stations of the Edison Company, which has now six stations, supplying 6,000 customers with over 300,000 incandescent and 3,700 arc lamps, and about 15,000 h. p. for power and miscellaneous purposes, forming the largest installation of any electric supply company in the world. Beyond this exhibit is a dark room in which is a joint exhibit of electric lamps manufactured by the General Electric Company and used by the Edison Company. This room illustrates various methods of lighting, including the latest plans for using reflected light, so that the lamps are not directly seen. There are some very clever theatrical and trophy effects in it. Electric signs and advertising specialties are also exhibited.

The whole space is railed, the posts carrying knobs in imitation of Edison lamps. The wiring, though "temporary," is very carefully and thoroughly done. It is enough to say that Messrs. Lieb, Van Vleck, Smith, Williams and other members of the company's well organized staff have planned the exhibit, laid it out, and given its operation their best thought and endeavor. A finer epitome of the central station art has never been shown.

DISPLAY OF SPRAGUE ELECTRIC ELEVATORS.

THE Sprague Electric Elevator Company have an exhibit in Section F, just back of the Interior Conduit Company, in which they group some of their latest and best machinery.



THE SPRAGUE ELECTRIC ELEVATOR EXHIBIT.

It is not material which lends itself to spectacular use, but there are a great many visitors to the show who appreciate its genuine importance, and who linger around the space to

study it. Mr. Frank J. Sprague is himself in constant attendance and much sought after. The exhibit comprises a multiple sheave elevator for passenger use in office buildings, etc.; a tandem and gear drum elevator, a house elevator, and a grouping of the regulators, switches and detail parts. A Sprague electric passenger elevator is also running in the building, able to carry a hundred people, and has been employed for all the distinguished guests. The worm and nut principle of the Sprague system has already been frequently described in our columns, and there is no need to go into details of it here. It may be added that a number of interesting modifications and special variations have been worked out.

THE GENERAL ELECTRIC EXHIBIT.

THOSE who are quizzically inclined at the show make good humored fun of the great General Electric Company, which has a neat display fronting on the Main Hall, the chief feature of which is a large frescoed background with a goddess of plenty in it. The average idea is that with less background of promise and more foreground of reality, the General Electric Company might have produced a better effect, for it is certain that the ordinary visitors to the show—and there are a great many of them—go away with the idea that the General Electric Company is one of the smaller concerns, whose chief business lies in the sale of a few pretty stage effects. The electrician knows better than this, of course, and knows that much of the adjoining exhibit of the New York Edison Company is to be regarded as an exposition of what the vast resources of the General Electric Company can do.

The space is neatly framed around with incandescent lamps, and includes standard and inclosed arcs as well, one or two fine electroliers being shown. There are also a number of smaller G. E. details, such as motors, meters, etc., and some bromide prints of apparatus and plants. Just off the space is a room containing a board at which one can switch on and off lamps of all sizes and voltages; and this is supplemented by some pretty shields, stage effects, etc. The whole has been tastefully arranged, and the "Brownie Room" in particular is crowded all the time.

THE GENERAL ELECTRIC CO.'S EXHIBIT AT THE ELECTRICAL EXPOSITION.

BORNE, SCRYMSER COMPANY, of New York, made a handsome display of oils suitable for dynamo, motor, cylinder, engine and machinery purposes. They supplied oil to a number of the exhibitors and in this way advertised their various products. Mr. Renshaw and Mr. J. H. Torrey were in charge of their exhibit and attended to the wants of all consumers.

"HABIRSHAW."

A STRONG personality tells anywhere, and when an individual reputation is built up by long years of success it takes a hold on the public mind that cannot be shaken off or

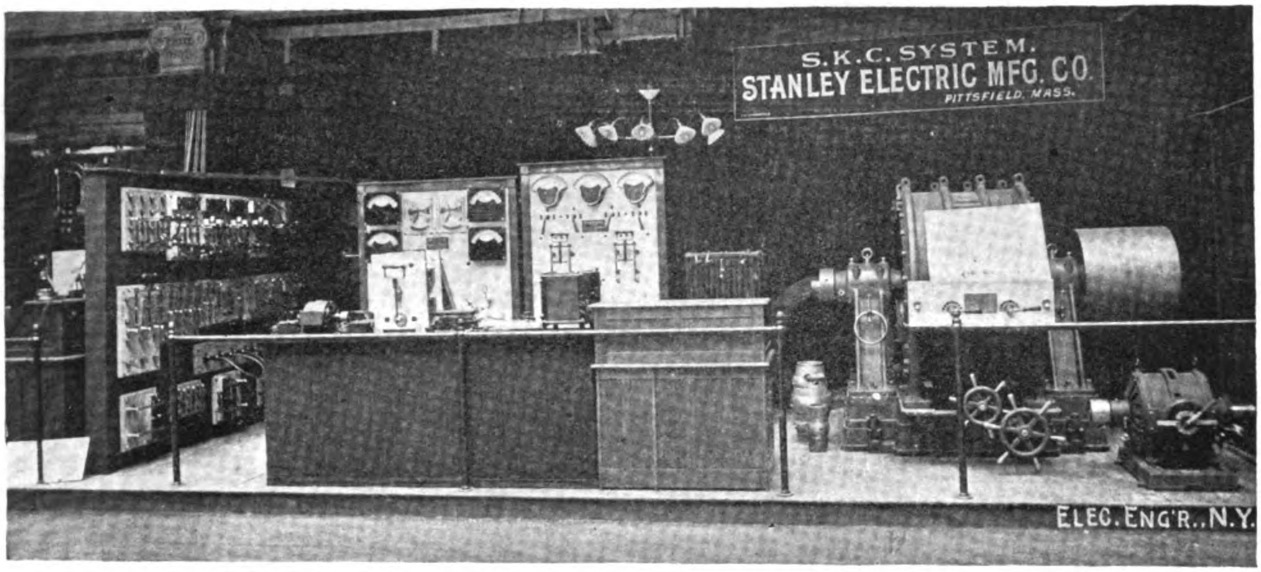
THE HABIRSHAW WIRE EXHIBIT.

disturbed. There are many fine wire and cable exhibits in the show, and it may be questioned whether a better grouping of them has ever been made before. Among these one of the most prominent and deservedly interesting is that of the India Rubber and Gutta Percha Insulating Company, of this city, who, true to their national colors, have their handsome booth effectively draped in red, white and blue, while the lamp "banners" on their "outer wall," bear in gleaming bands of light the universally-known name of Habirshaw. The booth, however, is not for mere display, but is business to the "core." Around it are reels of wire and cable, across its ends are sample boards; the central desk brims over with samples of Habirshaw products for all the purposes of telegraphy, telephony, electric lighting, electric power, etc. The exhibit also contains some very interesting examples, bare and covered, of the bars and cables made for the Niagara plant and power transmission, constituting some of the heaviest copper pieces

ever built. The exhibit is under the constant direction of Mr. J. W. Godfrey, general manager, associated with whom are Messrs. Harrington and Olsen, while Dr. Habirshaw himself is not an infrequent visitor on evenings when there is some chance of moving around with comfort.

THE EXHIBIT OF THE STANLEY ELECTRIC MFG. CO.

It is a fortunate thing that the Stanley Electric Manufacturing Company, of Pittsfield, decided to put a big machine in its space, for while it is a considerable strain on the floor, it typifies for the visitor the heavier class of apparatus not otherwise to be seen in the Main Hall, and gives an excellent idea of the degree of perfection reached in phase dynamos. It is indeed a beautiful machine, which finds admirers of its curves among the ladies who know very little of its intrinsic merits. Facing as it does on the Main Hall, one of the six exhibits that has the honor so to do, the Stanley Company enjoy considerable attention. The exhibit is excellently grouped. It includes not only the big 180 kilowatt generator, but single and two-phase motors, several Stanley transformers, switchboards and their equipment, measuring instruments, and a great variety of details, all showing care in production and beauty of finish. The exhibit was put in order under the direction of Mr. J. F. Kelly, who has also been in frequent attendance.



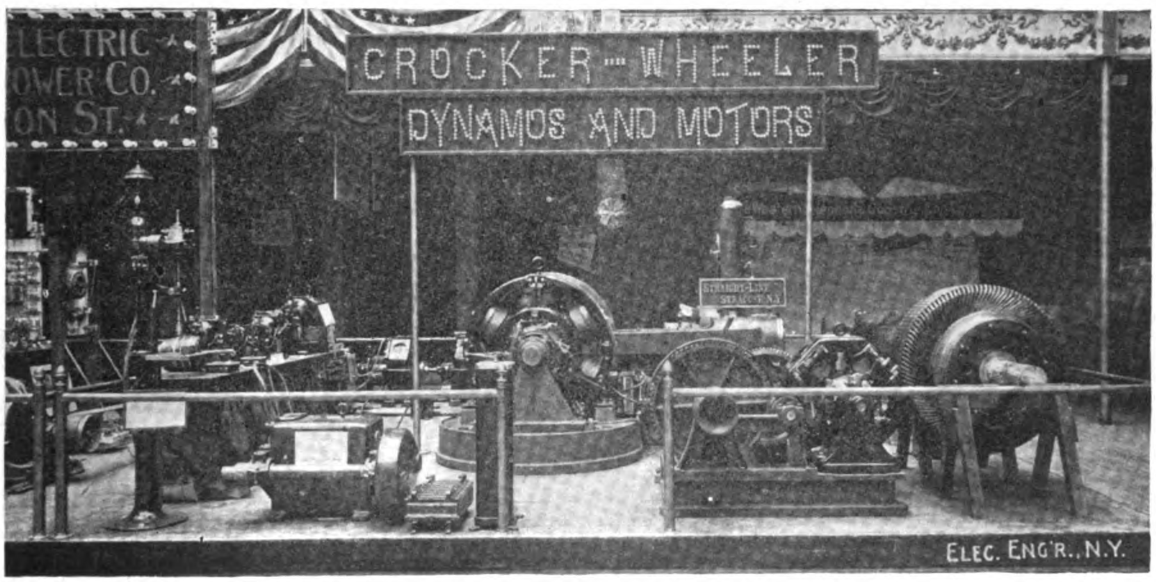
THE STANLEY ELECTRIC MANUFACTURING CO.'S EXHIBIT AT THE ELECTRICAL EXPOSITION.

FINE EXHIBIT BY THE CROCKER-WHEELER ELECTRIC CO.

SECTION L on the main floor is perhaps one of the most interesting and attractive of the exposition, both on account of the conspicuous place it occupies, and also because it embraces but three exhibits representing well known and progressive firms. One of these, near the main entrance, marked space 164, is occupied by the Crocker-Wheeler Electric Company, who have on exhibition a great variety of their products.

In the center of the display is a Straight Line engine directly coupled to a 56 kilowatt Crocker-Wheeler dynamo, compound wound, operated as a compound motor and driving the steam engine. An armature for a 250 horse-power dynamo and one for a 100 kilowatt direct connected machine attracts a great deal of attention, as does also the ironclad "mill motor," used for driving machinery in rolling mills. It is dust and water proof, and protected against mechanical injury. Such machinery will undoubtedly replace the steam engines used at present. The apparatus here is a 40 horse-power machine, and is used with an ingenious controller.

Motor dynamos transforming direct to alternating currents and 115 to 200 volts are shown, and a small motor is connected directly to the main shaft of a Prentice Tool Company two-

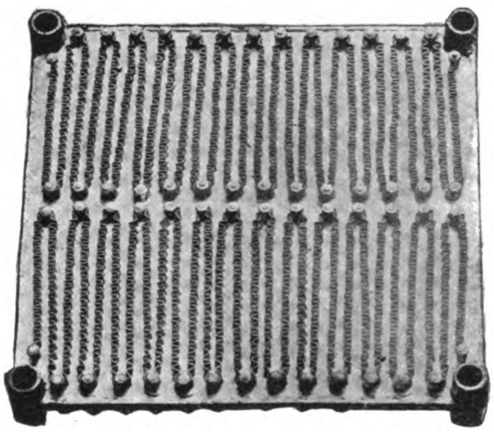


THE CROCKER-WHEELER ELECTRIC CO.'S EXHIBIT AT THE ELECTRICAL EXPOSITION.

speed sensitive drill. Small $^1/_{12}$ horse-power fan outfits with ball joints at the bases are in operation, and project the air at any desired angle. Besides these we see motor dynamos with automatic field cut-out, automatic brake motors for hoists, punch presses, etc.; a standard 230 volt, 3 horse-power motor, zigzag iron rheostats, the new automatic gravity drop starting box, which prevents a person from starting the motor should the current have been shut off from any cause without first putting in the starting resistance; also a 15 horse-power rotary transformer, with a primary of 115 and a secondary of 200 volts. A very instructive feature of the exhibit is the actual winding of small ⅛ horse-power and 65 horse-power elevator motor armatures by experienced men from the works at Ampere, N. J. It may be of interest to note that on the evening before the opening of the exposition a Crocker-Wheeler motor was run by the current brought from Niagara Falls, this being the first motor to operate machinery in the City of New York by that source of power. The following gentlemen are ready at all times to impart any desired information: Francis B. de Gress, Alfred D. Baldwin, H. D. Lufkin and Gano S. Dunn. Dr. Wheeler and Professor Crocker are also frequently present.

THE EXHIBIT OF CARPENTER AND LEONARD RHEOSTATS.

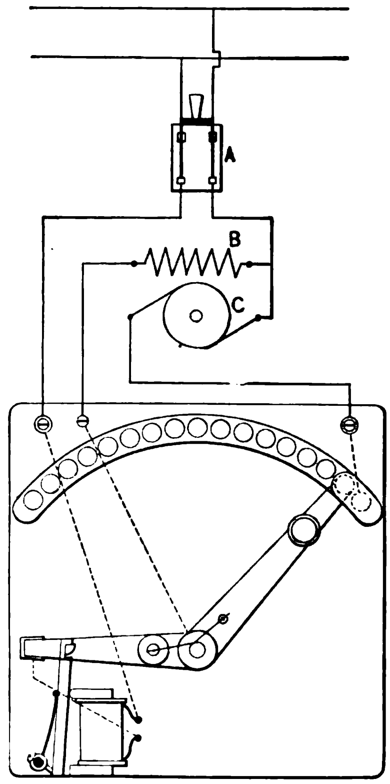
IN no branch of the electrical manufacturing arts has there been more real and rapid advance than in the construction of rheostats. When one remembers the huge, clumsy old contrivances, as big as a sentry box and as full of spiral wire as a spring bed, it is little short of amazing to find the same important functions of current regulation performed by a modest disc or slab no larger than a chair seat. Moreover, with the reduction in size and refinement in detail, has gone a lowering of price that is simply phenomenal. Rating efficiency against efficiency between old and new, it will be found that a modern rheostat can be bought for about 20 per cent. of the cost of three or four years ago.



Leonard Ribbon Rheostat.

There have been various workers in this field, but the fact that the Carpenter Enamel Rheostat Company, as represented by the Ward Leonard Electric Company, of Thirteenth and Washington streets, Hoboken, are the only exhibitors of rheostats in the exposition, is indicative of a good many things to the student of electrical industries. Messrs. Carpenter and Leonard are distinguished for having begun the reform in rheostat work and for having pushed it so far that they may be said to have literally created a new art. Their influence is felt abroad not less than here, for their goods go to every leading concern in Europe, while unsolicited orders pour in constantly from foreign houses.

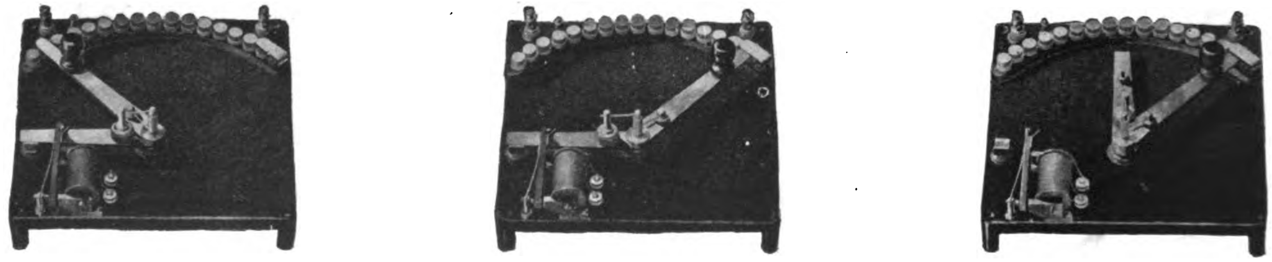
The Ward Leonard Company will hereafter be the representative before the public of the Carpenter Rheostat Company, whose goods it will market. It will introduce important new lines of apparatus based on existing methods, and will also rapidly develop new appliances due to the later inventions and patents of Mr. Leonard and Mr. Carpenter. As their highly interesting exhibit at the show proves, these two gentlemen have deliberately selected the field of heavy work upon which to concentrate their efforts more particularly, but they have had, owing to the demands on them, to bring out one or two specialties. The heating of air and water, however, as in the case of heating rooms, cooking, etc., they have let alone, believing that their work was most needed in what may, perhaps, be called "serious" work.



A.—Double Pole Switch.
B.—Motor Shunt Field.
C.—Motor Armature.

Diagram of Connections.

At the exposition, where they occupy Space 43, Section C, the Ward Leonard Company issue a new catalogue, which is in reality a clever and very valuable treatise on rheostats and their use. It contains a number of highly important tables, one notable feature of which is the evident scientific grading of the sizes, so that a purchaser can get his rheostat effects in any combination and degree best suited to his requirements. Hitherto, sizes and capacities have been widely and extravagantly apart, but with this catalogue in hand, any need can be economically filled.



Starting. Full Speed. Automatically Stopped.

Leonard Automatic Universal Rheostat.

The round type of Carpenter field rheostat is familiar, and a wide range is shown, while the classification in the catalogue is extensive and complete. The next item is a striking novelty, due to Mr. Leonard, and recently patented. It is an enamel

rheostat. of the appearance here indicated. It is well known that in earlier forms, fine wires have been embedded or laid flat in spirals in the enamel. There would seem to be, however, a limit to the capacity of the enamel to stand the sudden and frequent development of heat, and hence Mr. Leonard has devised a method in which thin metal ribbon is used, set in enamel, but standing out at right angles to the iron base-plate. Hence ensues an elasticity and radiation ability that is remarkable, while the general slight rise in temperature is also a very good quality. The ribbon is of special alloy, and does not appreciably deteriorate or oxidize. These Leonard enamel rheostats will take care of any large currents for heavy work.

The next novelty shown is the Leonard universal automatic rheostat, here illustrated in perspective and by diagram. Its quick action is a guarantee of protection against sudden overload of a motor or against the sudden cessation and return of current, or against the carelessness of the operator, or against practically any effect of current that would damage the machine.

The end aimed at is accomplished by one magnet placed in series with the entire motor current. This magnet consumes no appreciable amount of energy, and does not heat under any conditions to a detrimental degree, and does not affect the speed of the motor at all. In thus automatically opening the circuit to a shunt wound motor the main circuit is opened, but the shunt field, under all conditions, is kept connected upon the armature, the armature winding and field winding always form a closed circuit, and hence there is no field discharge and no sparking in opening the circuit.

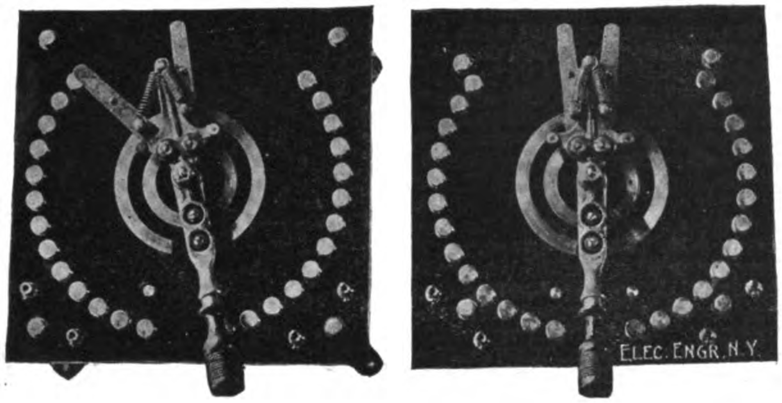
After the circuit is automatically opened it cannot be again closed, except by first inserting all the resistance of the rheostat, thus making it impossible to send an excessive current through the rheostat and motor. The rheostat contact lever has a spring always tending to insert the resistance. The lever cannot be left upon an intermediate contact. When the resistance is all cut out the lever is held by a friction clip. No carelessness on the part of the attendant or a stranger can possibly result in any damage. The arrangement of the magnet so as to perform its functions of safeguarding from each end of the armature is most ingenious and very prettily worked out. If anything wrong happens, the circuit has got to open.

Another neat piece of apparatus is the reversing controller, for motors ranging from ½ horse-power up to 100 horse-power. At the show one of the sizes can be seen in operation in the fine exhibit of the Niles Tool Works, and it may be here noted that hardly an exhibit of light and power in the building is without Carpenter rheostats on its armature or switchboards.

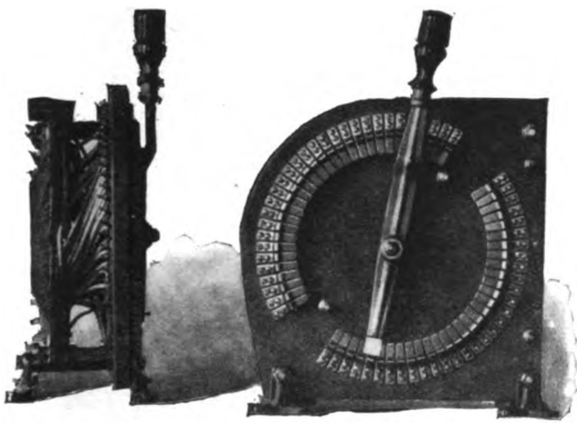
Theatre dimmers have of late years come to be an indispensable adjunct, and in the advertisement of the Ward Leonard Company in this issue of The Electrical Engineer a bank is shown as installed in the Star Theatre, New York. The details are as shown by the cut herewith. No fewer than 350 have been sold within the last nine months, and others since the opening of the show. The economy of space and the greater safety are incalculable.

Two minor pieces of apparatus seen in the exhibit at the show attract much attention from the public, namely, the Leonard flatiron and the Leonard soldering iron. In the former the concentration of heating effect is pushed to the utmost degree, but it finds a rival in the solderer, a large type of which is shown, intended for 500-volt street railway work. How a road can get along without such an appliance, it is difficult to imagine. There are a few other pieces of apparatus on view, but, as already said, though the enamel lends itself to many purposes, and though the company have sundry ingenious small appliances, it is the "heavy current" work that demands practically all their time and energy.

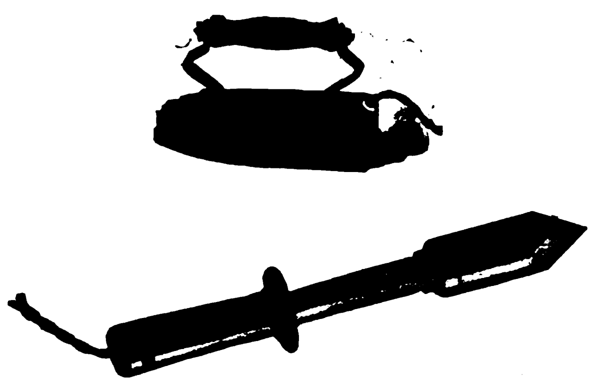
The catalogue, it may be noted in conclusion, contains a table of useful equivalents, by Mr. Leonard, for dealing with electric heating problems, and one due to Mr. Kennelly, giving ohmage, etc., for wires from No. 0000 down to No. 40, which runs 34,340 feet to the pound.



REVERSING CONTROLLERS.



THEATRE DIMMER.



LEONARD FLAT IRON AND SOLDERING IRON.

RUSSELL-SEE ELECTRICAL INDICATOR COMPANY.—The only exhibit of electric sidelights is that made by the Russell-See Electrical Indicator Company. Their booth represented, as it were, a ship at sea with sidelights burning, showing clearly the extended use to which their lights can be put in ships, locomotives, signal posts, etc. Their device consists of an ordinary cylindrical reflecting headlight, in which are contained two incandescent lamps, so connected that if one fails to burn the other will take its place and continue to burn and at the same time give notice of the change by means of an annunciator.

A CHOICE EXHIBIT BY THE BRUSH ELECTRIC CO.

"LIFE in the Old Dog Yet," might well be the sign hung up over the excellent exhibit made by the Brush Electric Company, of Cleveland, in the basement or generating plant. The exhibit occupies no less than 425 square feet, and is every inch of it solid with good apparatus. The space may be said to be divided into two parts, one devoted to the historical exhibit of the company and the other to the exhibit of their latest and most modern machinery. Mr. S. M. Hamill, general manager and vice-president, and Col. Rogers have both taken personal pride and pains in the arrangement, and have the pleasure of knowing that their efforts are appreciated daily by the public and by crowds of friends.

The historical exhibit consists of the Brush arc dynamo which was sold in 1877 to parties in Baltimore, who ran it for twelve years. Also a sixteen-light, 2,000 candle-power arc dynamo, which was run by the Fulton Worsted Mills, Fulton, N. Y., from September 1, 1879, to April 10, 1892, when it was secured for the exposition at the Columbia Exposition. Also a forty-light Brush arc dynamo, which was operated by the Berkeley Company, in Providence, R. I., from December 1, 1881, to May 19, 1893, when it was purchased for exhibit at the Columbian Exposition. These dynamos are exhibited just as they left the factory years ago. Not a bobbin or an armature has been rewound, or a shaft, wire or a commutator replaced.

The working exhibit consists of a new 80 light, 2,000 candle-power Brush arc dynamo connected to a 60 kilowatt, 200 volt motor. Eighty double Brush arc lamps hung gracefully around the exhibit are operated from the direct connected dynamo.

In connection with the direct connected 80 light dynamo is shown in practical operation a machine running with a load of eighty lights with a difference of potential not exceeding 1,500 volts between any part of the machine or circuits and the machine still maintaining its automatic regulation. To put it more plainly, these circuits are run direct from the terminals of the dynamo on any of which circuits the voltage does not exceed 1,500 volts, or, in other words, on any one of which circuits there are not more than twenty-seven 2,000 c. p. arc lights. This is an entirely new method of running on an arc dynamo and is exhibited for the first time in the Brush exhibit. It was devised and carefully worked out by Mr. C. M. Green, of the Brush testing department.

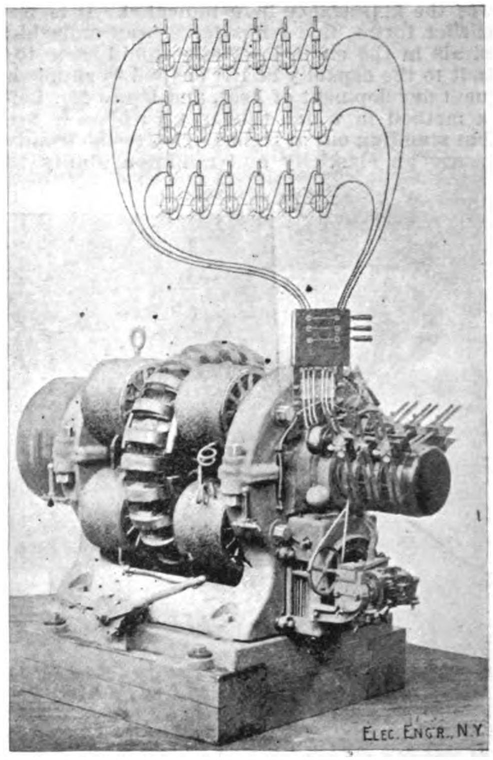


FIG. 1.—THE BRUSH, 3-CIRCUIT ARC DYNAMO.

There is also a 100 light, 2,000 candle-power Brush arc

FIG. 2.—THE BRUSH ELECTRIC COMPANY'S EXHIBIT.

dynamo and a 125 light, 2,000 candle-power Brush dynamo. These three large arc dynamos are of the very latest Brush type. They have been recently designed by the Brush company, who have already sold over 20,000 lights capacity of them.

A rack of the various styles of lamps which the Brush company manufacture is also exhibited.

EXHIBIT OF THE ELECTRIC STORAGE BATTERY CO. OF PHILADELPHIA.

As the development of the storage battery and its applications are of unbounded interest to the electrical engineer, as well as to the general public, its advantages having long been recognized, it is not at all surprising to see at all times an eager crowd surrounding the exhibit of the Electric Storage Battery Company, of Philadelphia. Their display in spaces 53-56, Section D, main floor, is one of the largest and best equipped of the exposition, as they do not simply show samples or models, but the actual pieces of apparatus, regardless of size and expense. We find here a battery of 128 Chloride accumulator cells, charged on the Edison 240 volt, three-wire circuit. They are charged directly through a motor booster of 90 volts; a complete controlling switchboard accompanies this outfit, containing Weston meters and Carpenter enamel rheostats.

A 21-foot electric launch occupies a prominent place in the center of the exhibit, the motor being exposed to view, also the battery racks. Adjoining this is the large type of central station cell of no less than 4,260 ampere-hours capacity.

Beside this stands an electric carriage, similar to the one which won the gold medal at Chicago. It is fitted up with a battery which will give it a maximum speed for thirty miles. The complete outfit weighs 1,700 pounds.

Besides these larger contrivances, portable batteries for fan motors, lamps and various other appliances are shown in generous quantity.

This splendid exhibit is in charge of the well-known authority on storage batteries, Mr. Charles Blizard, the general manager of the New York office.

THE ELECTRIC STORAGE BATTERY CO.'S EXHIBIT AT THE ELECTRICAL EXPOSITION, NEW YORK.

NOTES OF THE EXPOSITION.

During the week a set of Lieut. B. A. Fiske's range finding apparatus, intended for the new battleship "Iowa," has been added to the collection in the Loan Exhibit. It is complete with all the circuits, instruments, etc., and attracts great attention. It gives the range at two miles, with a possibility of error not exceeding 3 per cent.

The Electrical Luncheon which followed the cable-sending feats on Saturday night was served in a room in the roof garden, specially fitted up under the direction of Superintendent Nathan. It was a blaze of color, tastefully set off by plants and foliage. The electrical lighting effects were beautifully done by the decorative lamp department of the General Electric Company, under the planning of Mr. McAllister. The Birdsall Electric Manufacturing Company also contributed some choice pieces, including a bank of roses, etc., wired with lamps, a music box in circuit with the flowers, jardinières with lamps, cigar lighters, and other things that greatly interested everybody. The luncheon was served by the Murray Hill Hotel, and was cooked and warmed on the electrical apparatus loaned from the Edison exhibit. During the luncheon, the band played on an adjoining stage. After this agreeable interlude, Mr. Edison received the guests in his X-ray chamber, and gave them all an opportunity to inspect their own bones at the fluoroscope. The entertainment was given by the Exposition Company, to whom the credit is due for a most delightful experience.

A great many distinguished visitors have attended the show during the past week. Among them were the Corean Embassy; Donna Elvira de Bourbon, daughter of Don Carlos; Miss Sarah J. Farmer, daughter of the late Professor Farmer; various members of the Vanderbilt family, and practically all the fashionable contingent of New York society. The schools and

colleges have now begun to arrive, and last week saw several institutions represented, from Columbia College down. During the present week a great many others will be at the show.

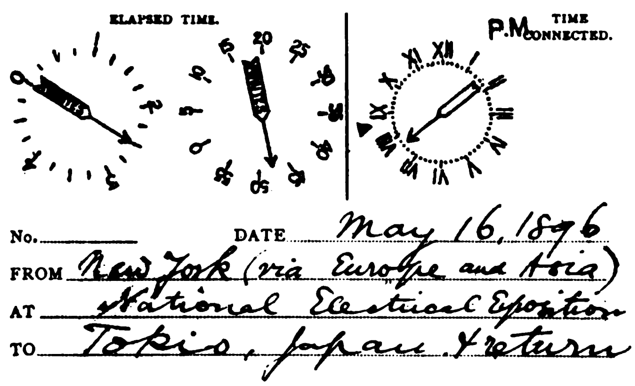
The Edison fluoroscope exhibit is a great drawing card. It is operated by Mr. Luther Stieringer, who has it under the care of Messrs. Fred Ott, Brown and Dally, from the laboratory, three tried and expert experimenters, who are not a little amused at their new experience in showing a delicate scientific discovery to thousands of people.

A lecture room for the display of X-ray slides, Geissler tubes, spectrum of the arc, etc., has been fitted up on the annex floor and is already a drawing card. Miss Crumbach, who has been helping in the Press Bureau, is the lecturer, and does her work well, Messrs. Stieringer and Osterberg having helped to equip her with the necessary stock of scientific popular talk.

Mr. G. E. Curtis, the photographer at Niagara Falls, N. Y., has sent to the exposition a magnificent series of views of the grand old Cataract, mounted. They have been grouped along the back of the Erie Canal exhibit and elicit unbounded admiration. Copies mounted or unmounted can be obtained from him at very reasonable prices. Better views of the Falls have never been taken.

KEEPING TAB ON THE ROUND-THE-WORLD MESSAGE.

IT occurred to Mr. Abbott, of the Calculagraph Company, that it might not be a bad idea to keep tab on the message to Tokio and back on Saturday night, and he accordingly did so. The card that went through the machine is reproduced herewith. It was noted at the time that a short fifty minutes



CALCULAGRAPH CARD USED FOR THE "ROUND THE WORLD" MESSAGE. TIME, 47½ MINUTES.

elapsed, but as there were many watches in use and none agreed, it was thought best by those who announced the news to be on the safe side. Mr. Abbott's forethought, however, secured the exact times and the exact duration, and the card herewith constitutes, therefore, part of the historical record.

GORDON-BURNHAM BATTERY EXHIBIT.

The Gordon-Burnham Battery Company, of New York, have an extremely interesting exhibit of their celebrated Gordon cell, which is largely used for open and closed circuit work. They have installed their exhibit in a tastefully decorated booth, and arranged the cells in pyramidal form. At intervals they have in circuit a few Geissler tubes, which serve to attract attention and fascinate the passers-by. Within the past few months the Gordon cell has made rapid strides and is now used on nearly every railroad in the United States for signal work. It has also become a prime favorite for telegraph, telephone and fire alarm work, besides all the usual domestic electric purposes. Mr. F. A. Burnham, general manager of the company, is in frequent attendance, but the exhibit is in charge of Mr. R. W. Gordon, vice-president, and W. C. Banks, electrician of the company.

HUGO REISINGER'S EXHIBIT.

Hugo Reisinger, of No. 38 Beaver street, New York City, is making a splendid exhibit of the celebrated "Electra" High Grade Nürnberg Carbons which he introduced into this country and which have become a prime favorite for constant potential and alternating current arc light.

The exhibit consists of carbons for direct and alternating current lighting, searchlight carbons and all kinds of carbons for telephone construction, batteries and smelting purposes.

We understand that the European factory of the "Electra" carbons is the oldest and by far the largest in Europe, and the carbons manufactured in the same have gained a world-wide reputation during the past ten years by their fine and uniform quality and high efficiency.

Two very interesting tables show the life of the "Electra" carbon as compared with others, and the weight of the dust produced by the various makes of imported and domestic carbons.

The booth, which is most tastefully decorated in white and gold, is much admired as being one of the handsomest at the exposition. Mr. John C. Outwater, who has charge of the electrical department, is in constant attendance, and his uniform courtesy in explaining the various diagrams has won many admirers. For an exhibit of carbons, Mr. Reisinger is to be congratulated upon imparting to it something of real live interest, and the exhibit has called forth much praise from many of the visitors.

EUGENE MUNSELL & CO.—The exhibit made by this company consists of large samples of block India and amber mica, also solid sheets of India mica segments, washers and mica for rheostats. The booth is very effectively decorated.

THE MICA INSULATOR CO.'S EXHIBIT.

THE MICA INSULATING CO. occupy the same booth as Eugene Munsell & Company, their exhibit consisting of a fine array of micanite segments, tubes, troughs, rings and plates. A striking feature of their exhibit is a large commutator made up of micanite, and also an armature made up of the same material.

THE BALL & WOOD CO. have in operation a 50 horsepower engine direct connected to a 100 kilowatt Siemens & Halske generator. The engine is equipped with the new Ball & Wood oiling system, gravity feed, dispensing entirely with the use of oil cups, and admitting of close inspection by the engineer while in use.

EXHIBIT OF THE NEW YORK CARBON WORKS.

NOT showy or sensational, but to the electrician and engineer very effective, is the snug exhibit of the New York Carbon Works along the north side of the main hall. Their display embraces all the leading specialties in carbon manufacture, with not a few lines in which they have made a distinctive reputation. Among the goods shown may be mentioned carbon discs or buttons, carbon granulated and carbon dust for microphones; carbon points for small apparatus needing contacts and non-sparking pieces. There are also carbon plates and cylinders for battery use, and a fine line of carbon brushes. The latter are of the type sold by the works to such roads as those of Chicago, the North Hudson County Company, the Brooklyn and Coney Island, and others.

The works also exhibit some fine carbons for arc lamps, which have been selected for many styles, and have now been adopted for the Nowotny lamp, to be seen also at the show. The carbon brushes are made in three qualities, soft, medium and hard, and run very smoothly and quietly. The lamp carbons are of equally high grade and are made to fit any requirement of current or voltage. The carbon plates are made from the best retort gas carbon, and are finished with much

precision and care. The range of cylinders and cups is large, for both open and closed types of primary battery.

At the show the works have been admirably represented by Messrs. G. W. Mills and H. N. Mills. The headquarters of the concern in New York City are at 39 and 41 Cortlandt street. The factory is located at Newark. The officers are J. S. Silver, president; Albert Storer, vice-president; W. H. H. James, secretary and treasurer, and G. W. Mills, general manager. In the absence of the latter well-known gentleman, who has been called away to close up some important orders, his son is taking excellent care of the exhibit.

THE EXHIBIT OF WOOLF'S ELECTROZONE.

IT would hardly be supposed that a very attractive exhibit could be made up out of electrolyzed salt water, but Mr. A. E. Woolf, with wonted taste and cleverness, has contrived to do it, and his space, No. 142 and 145, in Section H, immediately adjoining the historical and loan exhibit, and beautifully draped in yellow, etc., is one of the best, and always crowded. In the enclosure is a huge bottle, human size, of electrozone, and right in front lie framed extracts from the leading papers of America describing the use of this purifier and disinfectant at the New York water supply at Rikers Island of garbage; by the Philadelphia Board of Health, and elsewhere. Nearby are microscopes for showing the effect of electrozone when sprayed on living organisms in water. Supplemental to this are working models of the Woolf system of electrolytic bleaching, and the Woolf method of manufacturing chlorine and caustic soda by electrolysis. In fact, Mr. Woolf has the leading electro-chemical exhibit of the show, and is scoring heavily by his enterprise and by the fact that he is pushing

WOOLF'S ELECTROZONE EXHIBIT.

along a genuinely good thing. Besides the distribution of electrozone, he is giving away samples of "Meditrina," a concentrated solution to whose virtues in sea-sickness not a few who went to the last yacht races will testify.

MOORE'S "ARTIFICIAL DAYLIGHT" EXHIBIT.

During the convention of the National Electric Light Association, Mr. D. McF. Moore delivered a lecture to a crowded audience on his vacuum tube lighting. Since that time he has taken possession of a niche in the main flight of stairs, just off the main hall, where he has constructed an entirely inclosed booth. It is exteriorly draped in red and interiorly in white, and against the white background are placed a number of tubes, spirals, designs, etc., to illustrate the possible effects obtainable with his methods. It is only fair to say that this little modest room, where daylight is manufactured, and where Mr. Moore himself is often present as chief magician, is one of the most attractive and popular features of the exposition. Mr. Edison remarked laughingly that it was even drawing more people than the X-rays; and, as a matter of fact, as many as 2,500 people in a night have stood patiently in line in order to watch the cheery gleams of those long white tubes, "full of luminescent nothingness." Every visitor of distinction to the show has considered it his or her duty at least to see the Moore exhibit and then go away wondering over it.

EXHIBIT OF THE NATIONAL CARBON CO.

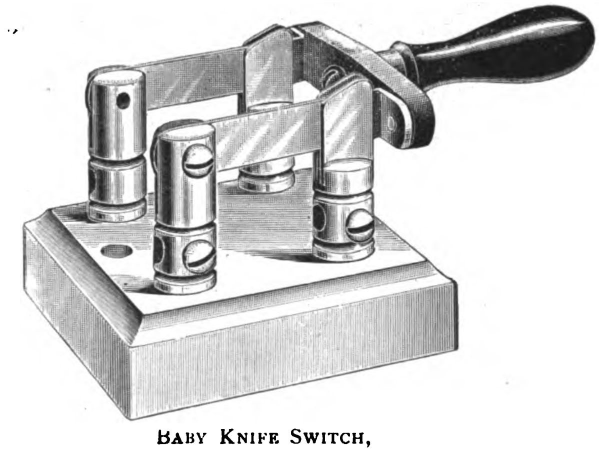
"SMALL, but select," is a phrase that would apply appropriately to the exhibit of the National Carbon Co., of Cleveland, whose display in Section G, Space 156, is here shown. The uninitiated often express surprise on finding that electrical carbons are in such variety and profusion, and here they see that even in the single item of arc light points the opportunities for diversity are numerous. Of arc carbons there

THE NATIONAL CARBON CO.'S EXHIBIT.

is an excellent display. It is supplemented by a wide range of battery carbons and accessories, an important and interesting category. Perhaps the most striking group is that of carbon brushes for dynamos and motors. The conquest of the carbon brush is here exemplified and demonstrated in a very forcible manner. The exhibit is neatly draped and rounded out with photographs of the great factory at Cleveland, O. Mr. B. F. Miles was present to see the exhibit put in good shape at the start.

THE H. P. BALL MANUFACTURING CO. AND ITS EXHIBIT.

A NEW corporation under the above title has just been formed for the manufacture of electrical apparatus and supplies, with headquarters at 101 Beekman street, New York City, the factory being located in Brooklyn. The company are prepared to furnish estimates on switchboards and special apparatus, and call particular attention to their baby knife



BABY KNIFE SWITCH,

switches, herewith illustrated. These are larger than the other makes on the market, having a capacity of 35 amperes, although they are called 25 ampere babies. The switch is mounted on a large porcelain base and has highly polished parts which are lacquered thoroughly to retain their brilliancy of machinery polish. The switch is well made by special machinery for this purpose, and the company is prepared to furnish the trade with a first-class article at a very low price. It will also manufacture and sell switchboards,

switches, distributing boards and electrical appliances of all kinds.

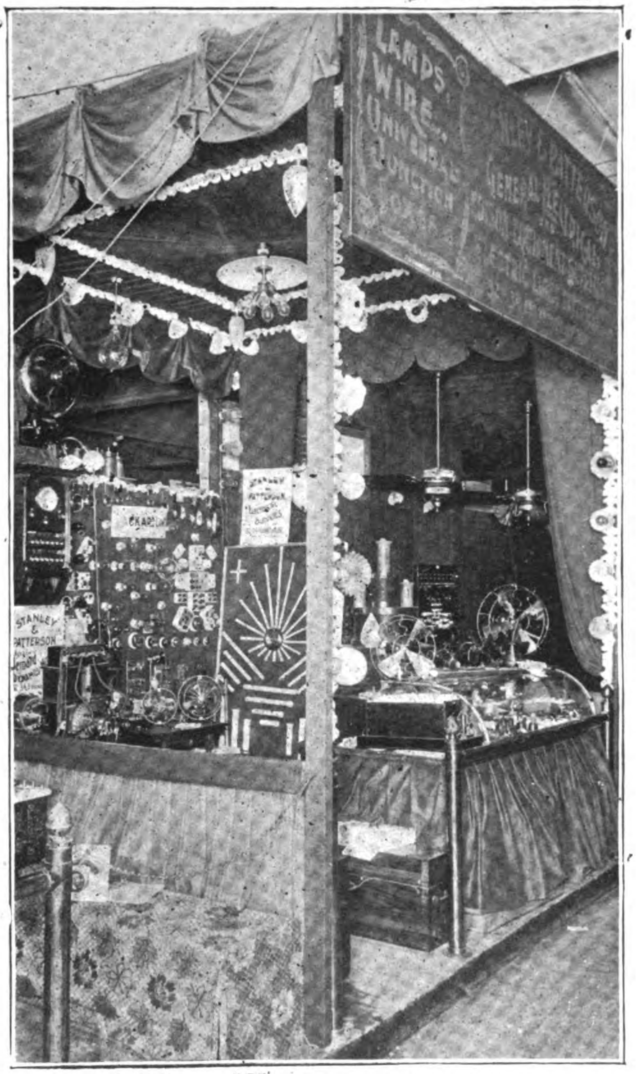
Mr. H. P. Ball, the president of the company, has been in the electrical field for ten years, most of which time has been spent with the General Electric Company, both in New York and Schenectady. While in this employ Mr. Ball designed the complete equipment of electric switchboards used in the United States Navy, and afterwards, as superintendent of the Carpenter Enamel Rheostat Company for two years, he designed a number of new appliances and improved types of rheostats.

The company's factory is thoroughly equipped with the best machinery and well adapted to turning out first-class work. They will be glad to correspond with all possible customers and agents.

At the exposition the company show a handsome switchboard of their "Baby" switches, with a capacity of 35 amperes, which is the biggest "Baby" on the market. In addition to these the company make switches and switchboards of any capacity. Their work, as illustrated at the show, is much admired.

THE STANLEY & PATTERSON EXHIBIT.

STANLEY & PATTERSON have one of the most attractive booths in the exhibition, consisting of all kinds of general electrical supplies. Among the specialties are Packard lamps, the booth being lighted by fifty 16 candle-power lamps of different colors and one 500 candle-power mogul lamp. A part of



THE EXHIBIT OF STANLEY & PATTERSON.

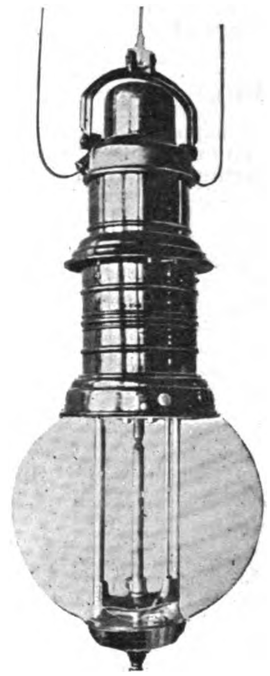
these lamps are run by a motor generator manufactured by E. G. Bernard Company, of Troy, N. Y.

In one side of the booth is placed a sample board, nicely arranged, of Brunt & Thompson's porcelain tubes. Near the center of the booth is a pyramid of Paranite wire, which is made by the Indiana Rubber and Insulated Wire Company. Jonesboro', Ind.

The exhibit is in Section F, on the main floor, and is thus advantageously placed. It catches everybody's eye, and having attracted attention, holds it.

THE REACTANCE SYSTEM OF ARC LIGHTING.

ONE of the most interesting arc lighting improvements shown at the exposition is that known as the "reactance system," the invention of Mr. W. S. Horry, who is kept busy explaining it in the booth of the United Electric Improvement



THE HORRY REACTANCE LAMP.

Company. Mr. Horry brought out this system in 1894.

Lamps of the ordinary Helios type are used with the addition of a small coil of thick wire built in them. The lamps are in series and are fed from the primary current of an ordinary alternator. The system is automatic, the current on the line remaining constant even if the carbons are all burnt away. There are no transformers, fuses or shunt spools employed.

The complete system comprises one transformer, which is located at the station, and a small switchboard. With these the proper current can always be served into the line, so that forty or less 2,000 candle-power lamps can be run on one series line from a 1,000 volt alternator, or eighty lamps may be run in series from a 2,000 volt alternator.

The current required from the alternator varies with the number of lamps in series and on the line itself a constant current of fifteen amperes is used.

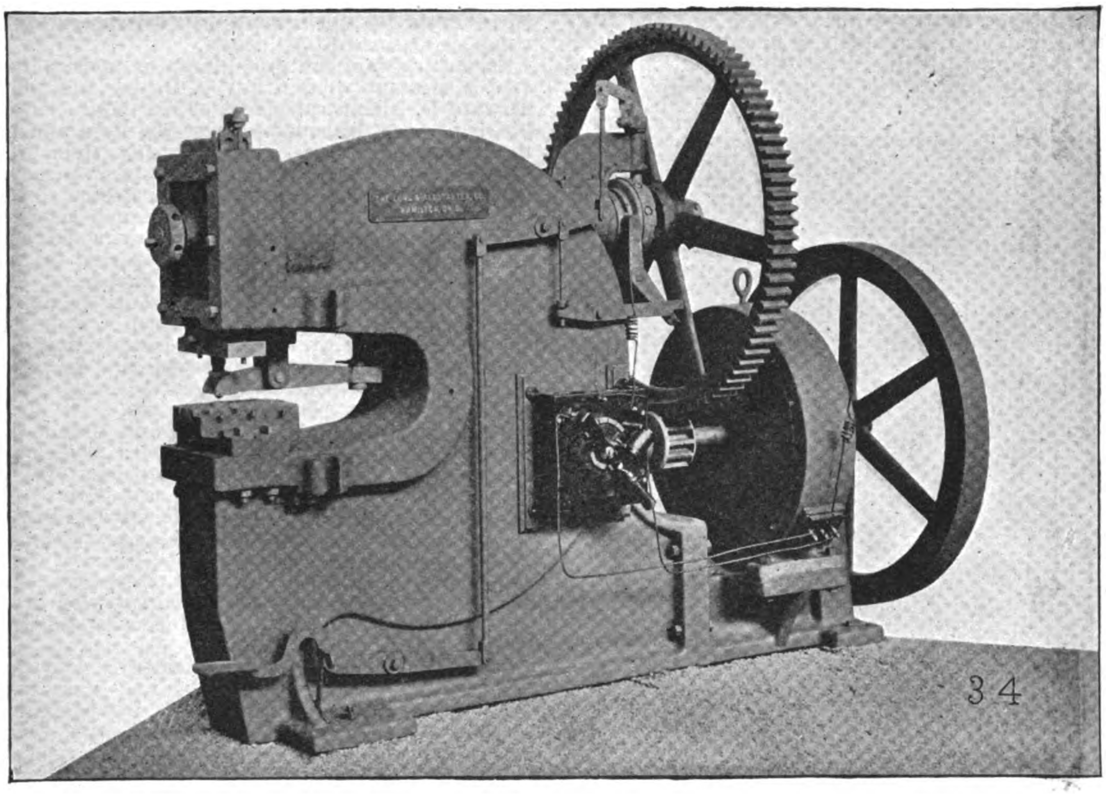
One of the strongest features of the system is the low cost of installation, and in this respect it is claimed to be far superior to the transformer system. Judging by the comments of electric light men who have seen the system and heard Mr. Horry's explanations of it, a rapidly increasing application of it may be looked for. It is already in operation on a dozen street lighting stations, and all the managers and engineers visiting the show insist with genuine anxiety on getting full details.

SPON & CHAMBERLAIN.—Glancing over this company's exhibit, the old saying is recalled, that we cannot have too much literature. Their exhibit is very complete, and Mr. Spon himself gave it his personal attention.

THE OKONITE CO.—Well located to the left of the main entrance are the cosy quarters of the Okonite Company, presided over by Captain W. L. Candee and Mr. George T. Manson. The booth is tastefully decorated in yellow, and is a reception room as well as a bureau of information. The most characteristic point about the exhibit is the total absence of all wire coils, a few samples of Okonite mounted on cards being all there is to remind the visitor of the company's mission in life. The company is evidently of the opinion that not to know Okonite is to confess oneself unknown. Gum-chewing young ladies gaze with envy upon a 700-pound ball or "biscuit" of Para rubber which forms the pièce de résistance of the exhibit, and two football teams are now being organized to play a game in which the great Okonite ball will be used.

A CARD MOTOR-TOOL UNIT.

We illustrate herewith one of the many applications of electric power to which the Card Motor and Dynamo Company have been paying special attention with much success. The tool shown is a Lang & Alstatter punch, and, as will be observed, the location of the motor is such as to interfere in nowise with the best and most economical operation of the tool. These direct-connected Card motors are a feature of the show.



Lang & Alstatter Punch Driven by Card Motor Direct Connected.

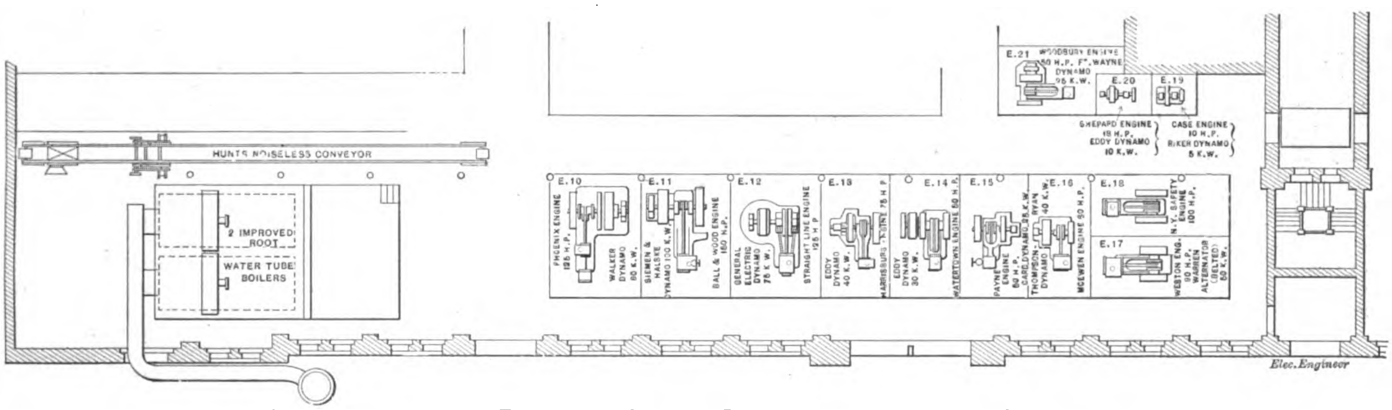
EXPOSITION POWER PLANT.

Probably the most instructive object lesson, to every steam user visiting the exposition, is the truly magnificent display of engines and dynamos in the generating department. True, the results are not as large and imposing as those shown at the Columbian Exposition, but for design and execution from both the electrical and steam engineering standpoints the present display may fairly be said to eclipse anything thus far brought to the notice of the public.

The accompanying diagram will give some idea of the extent and variety of the display. The most characteristic feature, of course, is the proponderating number of direct connected units, only two out of the twelve dynamos being driven by belts. The unit nearest the boilers is that of the Phœnix engine of 125 horse-power, which drives a Walker 50 kilowatt dynamo. This is the only compound engine shown at the exposition. Then follow in regular order the following: Siemens & Halske 100 kilowatt dynamo, with interior pole pieces, direct connected to a Ball & Wood 150 horse-power engine; General Electric multipolar 75 kilowatt dynamo direct connected to a Straight Line, 125 horse-power engine; Eddy 40 kilowatt dynamo direct connected to a Harrisburg "Ideal" 75 horse-power engine, which unit was illustrated in our last issue; Eddy 30 kilowatt dynamo direct connected to a Watertown 50 horse-power engine, Card 25 kilowatt dynamo direct connected to a Payne 50 horse-power engine, Thompson-Ryan 40 kilowatt dynamo direct connected to a McEwen 60 horse-power engine. The two dynamos at the end of the line are belt driven; one of these is the 50 kilowatt Warren alternator (the only alternating machine in the power plant), and is driven by a Weston 90 horse-power engine, and an 80 horse-power Crocker-Wheeler dynamo driven by a 100 horse-power New York Safety engine.

On the other side of the main aisle are two small direct driven units. That at the end consists of a Riker 5 kilowatt dynamo direct driven by a Case 10 horse-power engine, and in the adjoining space is an Eddy 10 kilowatt dynamo driven by a Shepherd vertical engine. Finally, there is a 25 kilowatt Fort Wayne dynamo direct driven by a Woodbury 50 horse-power engine.

The power plant is completed by a pair of 500 horse-power Root boilers, to which coal is supplied by a Hunt noiseless conveyor, which also disposes of the ash.



Arrangement of the Engine and Dynamo Plant at the Electrical Exposition.

HARRISON J. SMITH.

THE president of the National Electrical Exposition Company, Mr. H. J. Smith, has found his position one of so much importance in the eyes of the public of New York and of the electrical community that it is likely he would hardly have accepted his office had he known of the fierce light of journalism that would be brought to bear upon him and upon his conduct. He has, however, stood the ordeal with a due admixture of modesty and equanimity, and now it is in order to congratulate him upon the success of the great enterprise which has been uppermost in the thoughts of himself and associates for

HARRISON J. SMITH.

so many months past. Mr. Smith, as a typical central station man, was a fortunate selection for the post, while the curious compound of aggressiveness and conservatism that makes itself felt in all his actions and in every conversation, was just about the element needed to approve the good things and frown down on the undesirable.

Mr. Smith is the superintendent of the Edison Electric Illuminating Company, of New York, the largest of its kind in the world, and nothing more need be said to indicate the nature of his daily duties, and of the work required in their discharge. It has been good training for the control of an electrical exposition.

SUPT. MARCUS NATHAN.

Upon no man has the actual work of putting the National Electrical Exposition in good shape fallen more heavily, to be discharged more efficiently, than Mr. Marcus Nathan, the cheery and imperturbable superintendent. His familiarity with the vast building and with exposition methods in general have been invaluable, and while the exigencies of the present case have presented many problems, Mr. Nathan has mastered them all successfully. Only by dint of hard work could this have been done, and Mr. Nathan has literally camped on the spot, spending days together within the building. His courtesy and kindness to all, even to exasperated exhibitors with real or imagined grievances, have won him hosts of friends in the electrical field. His work has been genuinely well done.

MR. S. M. HAMILL, JR., was a visitor to the show last week on several nights, escorting well known members of New York society, who, under his expert guidance, saw the best of everything in the minimum of time.

MR. A. A. KNUDSON has lent valuable aid to the exposition in fixing up the electrical part of its inaugural exercises. He has also arranged other features, including a lamp baton for the band conductor.

MESSAGES AROUND THE WORLD FROM THE EXPOSITION.

ON May 16, at the National Electrical Exposition, a notable feat in land and submarine telegraphy was attempted and successfully carried out, to the great credit of all concerned. In addition to the sending of messages around the world, Mr. Chauncey M. Depew delivered a fine oration on "The Progress and Future of Electricity." There was an audience of some 10,000 people.

To demonstrate the promptness of modern telegraphic service, a message written by Dr. Depew and addressed to Mr. Edward D. Adams, president of the Cataract General Electric Company, was transmitted over the lines and connections of the Postal-Telegraph Cable Company from New York, via Chicago, Los Angeles, San Francisco, Vancouver, Winnipeg and Canso, to London and back, via Boston to New York.

Col. Albert B. Chandler, president and general manager of the Postal-Telegraph Cable Company acted as the sending operator in the north balcony, and started the message on its long journey at 8:34 o'clock. Mr. Thomas A. Edison, who in his younger days was also a telegraph operator, received the message in the south balcony when it came back, handing out a copy in his own beautiful handwriting, to Mr. Adams, at 8:38 o'clock, the time occupied in carrying the message over 15,000 miles of a part of the Postal Company's overland and cable system being exactly 4 minutes.

The circuit between New York and Buffalo was energized with electricity generated by Niagara Falls at the plant of the Cataract General Electric Company. Mr. Depew's message and Mr. Adams' reply were as follows:

Message of Chauncey M. Depew to Edward D. Adams:

"God created, nature treasures, science utilizes electric power for the grandeur of nations and the peace of the world."

Message of E. D. Adams to C. M. Depew:

"Mighty Niagara, nature's wonder, serving men through the electric circuit, proclaims to all peoples science triumphant and the benevolent Creator."

When the message reached London, a copy was handed to the Eastern Telegraph Company and was forwarded by it over various lines and cables via Lisbon, Gibraltar, Malta, Alexandria, Suez, Aden, Bombay, Madras, Singapore, Hong Kong, Shanghai and Nagasaki to Tokio, Japan, returning thence via London and reaching the Exposition Hall at 9:24. The time was in reality a little short of this, but watches vary.

The Western Union Company and connections also transmitted a copy of the message from New York through Mexico, down the west coast and up the east coast of South America, thence to Spain and back to New York, the time occupied being 21 minutes. The arrangements for Mr. Depew's oration and the demonstrations of what is possible in long distance electrical transmission were largely due to the energy and care of Mr. F. W. Hawley, vice-president and general manager of the Cataract General Electric Company.

These demonstrations of the annihilation of time and space by means of modern telegraph facilities are the most extensive that have ever been undertaken. The invention of instruments and the construction of the vast system of telegraph lines and cables which make these remarkable feats possible have all been the work of scarcely more than fifty years, and a large portion of it of the last dozen years.

The very men who handled the messages in the hall are older than the science of which they are the masters, and there were many present who remembered the occasion of the sending of Morse's world-famous first message: "What hath God wrought?"

The Postal Company's instruments used were of their latest pattern, with aluminum levers. They are handsomely mounted on an ebony base, and will be presented to the Smithsonian Institute in Washington, together with attested records as to the time occupied in transmitting the massage and copies of every newspaper in the world in which the occasion may be noticed. These will be carefully preserved by the Smithsonian Institute as evidence to future generations of the advanced state of electrical science in this year of 1896.

The Western Union circuits were in the care of Vice-President Horne, General Manager C. A. Tinker, and Mr. G. W. Dickson as operator. The company occupied the center of the main balcony, and their apparatus was put within the frame of Moore tubes in which Governor Morton stood to open the exposition. By courtesy of General E. S. Greeley, the famous golden key was used for their work, and it attracted great attention.

The return of the messages after their flight through space was signalized by guns in circuit with the instruments. This part of the programme was carefully looked after by Mr. A. A. Knudson, and was a great success, the sharp boom of the gun giving just the needed emphasis to the course of events.

Over each gallery balcony was hung a huge glass arrow

built up of Moore's vacuum tubes. In the dispatching gallery, the arrow was headed to the air, away from President Chandler's key table. In the receiving gallery, the other arrow was headed downward towards Mr. Edison's table. As the messages left and returned, these huge glittering arrows were filled with strong phosphorescent light, whose flashes, as the circuit was made and broken now and again, served to give the vast crowds below and around a vivid and beautiful idea of electricity's actual passage around the circuit of the world from the balconies so near together.

EXHIBIT NOTES.

THE CRANE COMPANY display a full line of extra heavy valves and fittings up to and including 18-inch. They also exhibit a very large flange coupling, and other high pressure steam specialties, the good points of which are carefully explained by Mr. Fred. Mitchell.

THE NEW YORK LEATHER BELTING COMPANY have a tastefully decorated booth in which are displayed a 72-inch three-ply belt manufactured for the Louisiana Electric Light Company and a 42-inch wide two-ply belt. The decorations on their booth consist of columns of leather belting tied together. The exhibit is in charge of Mr. Robert Hilleck.

THE NEW YORK SAFETY STEAM AND POWER COMPANY exhibit in the basement a 14 by 16-inch horizontal engine belted to a 55 kilowatt Crocker-Wheeler generator, which supplies current for much of the lighting of the various exhibits of the exposition. The exhibit is complete in every detail and the successful working of this engine from the start deserves credit.

THE FERRACUTE MACHINE COMPANY, of Bridgeton, N. J., have a small space in which they have set up four punch presses, operated by electric motors, which are kept busy stamping out pretty souvenirs of aluminum. This company make presses for stamping armature discs, and Mr. Smith, of the company, appears to be the busiest man at the exposition, explaining to many the good points of his machines.

THE U. S. MINERAL WOOL COMPANY, of New York, attract a large number of visitors to their exhibit, which they find very interesting. It shows the process of turning hard slag into soft mineral wool suitable for the purpose of covering steam pipes so as to prevent radiation of heat. They also exhibit all forms and sizes of copper gaskets, pipe coverings and a variety of devices useful to the steam engineer.

THE ASHCROFT MANUFACTURING COMPANY'S display comprises a full line of pressure, vacuum and recording gauges. The Consolidated Safety Valve Company's exhibit in the same booth consists of a complete line of safety valves. Hayden & Derby have their exhibit with the above two companies, which consists of the Metropolitan double tube injector. Mr. J. Derby and Mr. F. T. Tapley represent the three above companies.

THE CLONBROCK STEAM BOILER COMPANY, makers of the Morrin "Climax" and the Morrin "Compound" boiler, display a small 10 horse-power boiler which they exhibited at the World's Fair, and several photographs showing a few of their various installations; they also display a photograph of the 20,000 horse-power "Climax" boilers to be installed in the new plants of the United Electric Light and Power Company, of New York City.

DALE, FARRELL & COMPANY, owing to the great call for bicycles, have gone into the bicycle business, and exhibit a bicycle, the frame of which is made entirely of wood. They also show a novel bicycle lamp which attracts a great deal of attention from visitors, especially those that use the wheel. They have perfected a new primary battery from which they expect great results, and show samples of it in their exhibit, which is in charge of Mr. Geo. A. Lietz.

THE PHŒNIX IRON WORKS, of Meadville, Pa., builders of the Dick & Church engine, show a compound horizontal engine which is one of the finest exhibits of its kind. It consists of a 50 horse-power engine direct connected to a Walker generator, the construction of the sub-base and method of supporting the cylinders being unique. Another peculiarity of the engine is that a heavy wheel is carried next to the generator, whereas the ordinary construction is to have no wheel on the generator side of the engine. Mr. C. A. White represents the company at the exposition.

MR. ROBERT A. KEASBEY, of New York, agent for Magnesia sectional covering, manufactured by the Keasbey & Mattison Company, of Ambler, Pa., have one of the finest exhibits in the line of pipe covering in the building. It consists of sectional samples of the different styles and shapes of coverings for steam pipes. This company have the distinction of supplying all the pipe covering of the exhibition, and also supplying nearly every ship of the U. S. Navy. Mr. C. H. Lietze, representing Robt. A. Keasbey, distributes a very pretty souvenir in the form of a calendar.

A VERY INTERESTING wall exhibit is that of De Veau & Company, New York. Many specialties are here exhibited, such as telephone exchange switchboards, which are connected at various points throughout the building; also wall sets of every description, for private use and exchange work; long distance apparatus, magneto bells, complete telephones, and their new carbon ball transmitter, which is shown in parts so that its construction may be inspected. Their steel "watch case" receiver only weighs 6 ounces. Mr. A. De Veau superintends this exhibit in an able manner.

THE JEWELL BELTING COMPANY, of Hartford, Conn., show a large assortment of belts, among which are a three-ply 69-inch dynamo belt sold to the Norwich Electric Light Company; a four-ply 79-inch belt, one inch thick, sold to the Washburn & Moen Manufacturing Company, of Worcester, the largest belt ever manufactured; and a 48-inch dynamo belt for the Passaic Electric Light Company. Mr. Chas. E. Ainsworth represents the Jewell Belting Company during the exposition, and Mr. Chas. E. Newton and Mr. C. L. Tolles were much in evidence during convention week.

THE GOLD STREET CAR HEATING COMPANY have arranged a very attractive working exhibit. They claim an almost complete conversion of electrical energy into heat, a possible graduation of heat, called the first, second and third degree, good workmanship and material, the facilities for making the heaters to suit any circuit, car or dwelling, and a handsome external appearance. On a recent evening, Mr. George J. Gould spent some time at this display, examining the various heaters, and expressed himself as very much pleased with their working. The display is presided over by Mr. John E. Ward and Miss Harriet Becker, who impart much valuable information and distribute to those interested, circulars and a report of a series of tests made on the heaters.

WHERE IS THE FIRE? is the question asked by many anxious visitors to the exposition. They hurry to the spot where the gong sounds to find themselves at the exhibit of the Gamewell Fire Alarm and Police Telegraph Company, who are showing in a most conspicuous and advantageous manner the working of their fire alarms and police signal systems. On each corner of the space marked 73—74 stands a lamp post, one carrying a fire box, the other a police call box, such as the company has installed in many of the largest cities. These boxes are connected to a central station and are in actual operation. They also show a fire alarm whistling machine, which, as the name indicates, whistles the alarm, instead of striking a gong. Numerous other devices complete this exhibit which demonstrates admirably the recent advancement which has been made in the application of electricity to the protection of human life and property. Messrs. A. L. Tinker and Chas. F. Waulen preside over this display.

J. C. VETTER & COMPANY, of New York and Philadelphia, who occupy the large corner space marked 80 to 81, Section J, have on exhibition a large variety of their electro-medical apparatus. A special tap is employed to obtain 110 volts, which device permits the lamp to remain burning while at another point of the socket the current may be tapped for other purposes. This is a new appliance, ingenious and useful, as it does not compel one to sacrifice light when desirous of using the current for other purposes. A small switchboard for galvanic and faradic currents, with Vetter carbon controller, and a very fine cabinet (similar to the one used at St. Luke's Hospital) is shown, which combines cautery devices and a diagnostic light. The Vetter dry battery which won a World's Fair prize is also shown. The exhibit also includes batteries, and many useful devices for medical and dental purposes. The exhibit is in charge of Mr. D. B. W. Bentley, who in a most able manner explains the workings of the various appliances.

THE HERZOG TELESEME SYSTEM.—Mr. F. B. Herzog is daily receiving at his booth the warm thanks of thousands of weary travelers who have used the teleseme to summon up cooling drinks and other necessaries in hotels during their travels. Though small, the Herzog teleseme exhibit is one of the most interesting in the whole exposition. It shows how intelligent thought has wrought undreamed of improvements in house and hotel communications. Among the variety of devices including the now well known teleseme is the Herzog hotel annunciator. One is fairly taken aback to see a 600 hotel annunciator board occupying no greater space than 14 by 14 inches. This is accomplished by using platinum buttons instead of the time honored arrow or electro-magnetic "drop." These buttons are immersed in a clear chemical solution and when the hotel guest calls, the little platinum button becomes discolored by the decomposition of the solution on its surface. When the hotel clerk has noted the call, he presses a rubber bulb, which injects air into the solution and washes the deposit off the platinum button, which reappears as bright as a new dollar. The Herzog police signal system is also shown in working order. Mr. Herzog and his bright young assistants keep the crowds well informed on the teleseme system.

THE D. VAN NOSTRAND COMPANY exhibit a full line of electrical literature and other technical works. Mr. C. L. Speirs is in charge.

THE PECKHAM MOTOR TRUCK AND WHEEL COMPANY exhibit one of their cantilever street car trucks, which have gone into extensive use all over the country.

A GREAT many favorable comments have been passed upon the wall display of Messrs. Geo. P. Hall & Son, New York, who show a beautiful collection of photographs of every description, exhibiting wonderful detail and beauty of tone.

MR. A. O. SCHOONMAKER, of New York, has a fine exhibit of mica sheets and stamped mica in all the various shapes required. The most important feature in Mr. Schoonmaker's exhibit are mica washers, shown in all sizes, and of which the firm make a specialty.

ONE OF THE most attractive exhibits at the exposition is that of the Birdsall Electric Manufacturing Company, of New York, manufacturers of electrical novelties, surgical and dental apparatus, electric illuminated clocks, musical jardinières, etc., and many very interesting and profitable advertising specialties. Mr. Birdsall himself welcomes the many visitors to his exhibit.

THE STIRLING COMPANY.—Among the noteworthy exhibits is that of the Stirling safety water tube boiler of 100 horse-power erected ready for the brickwork, so that the whole internal construction is visible. The simplicity of design of this boiler attracts much attention, as there are very few working parts, and very little machine work necessary in its construction, the tubes being all screwed directly into the drums.

HUEBEL & MANGER, of Brooklyn, N. Y., display a full line of electric bells, push buttons, etc., including their well-known style F bell, in sizes from three to fifteen inches, also a large variety of wood and iron box bells of different styles and sizes. Their representative, W. W. McChesney, Jr., is in attendance at the exhibit, and Mr. Huebel and Mr. Manger are on hand during the evening shaking hands with their many friends.

THE R. D. NUTTALL COMPANY, of Allegheny, Pa., exhibit gears and pinions for all systems, motor bearings, trolleys and trolley parts. They have the largest gear cutting establishment in the United States and are prepared to make gears and pinions for any desired system. Many radical improvements have been made by them in trolley devices and many advantages are claimed for them. Mr. T. J. Lord has charge of this railway supply exhibit.

THAT THE QUALITY, and not the size of an exhibit, determines its value to the profession is well exemplified by the display made by the Ball-Bearing Company, of Boston, Mass. We find here an upright carriage wheel on a stand, mounted upon ball-bearing axles, which with an ordinary impulse will run for 12 minutes before coming to rest. Other running machine parts, such as cable pulley, are shown, demonstrating the value of ball-bearings as friction reducers.

WAGNER ELECTRIC MANUFACTURING COMPANY.—The most complete exhibit of transformers is that made by the Wagner Electric Manufacturing Company, of St. Louis, in which they show all sizes of transformers and auxiliary apparatus. They gave away a very pretty inkstand in the form of a transformer, it being about 2 inches high, gold plated, illustrated in last week's issue. Mr. E. H. Abadie demonstrates how the transformers are used for commercial work.

THE VACUUM OIL COMPANY, of Rochester, N. Y., have a business-like exhibit in the engine and generator department over which Mr. E. A. Record, general sales agent for the electrical department, presides with all his usual courtesy. This company has been particularly successful in the manufacture of lubricating oils for engine and dynamo purposes, and those in charge of the generating plants in the exposition appreciate the quality of the oil which they procure from Mr. Record, and evidently know a good thing when they see it. Cans of oil are on hand at all times, and all comers are cheerfully supplied.

THE LAKON COMPANY, of Elkhart, Ind., exhibit ten transformers, ranging in sizes from 250 to 10,000 watts. They claim for these transformers good regulation and minimum watts lost in iron, well set forth in a descriptive circular distributed at the booth. They also exhibit an open type transformer of 5,000 watts capacity and 1, 2, 3, and 5 light economy coils. The E. B. Latham & Company have in operation in this space at present one of the Tuerk alternating current ceiling fans, which is very efficient and needs oiling but once a year. Mr. E. B. Latham, Eastern agent for these companies, is in charge of this very useful display.

AS IF GUARDING the Loan and Historical Exhibit a huge mast-arm with lamp attached extends from the very interesting corner display of the Peck Electric Company, T. H. Brady, and the American Carbon Company; in the space marked 82, Section J, we find here carbons of every description, mast-arms, cut-out boxes, motor brushes, battery carbons, carbon cylinders, rods, pole irons, iron brackets, sleet proof pulleys, storm-protectors and arc lamps; a very handsome chandelier, two Helios arc lamps, and a model of an electric fire engine which attracts a great deal of attention. In a most happy manner Mr. E. F. Peck imparts information on the great variety of apparatus made by the above companies.

OPPOSITE the Loan and Historical Exhibit is a space marked 46, Section C, Main Floor, which could not have been utilized for a better purpose than to exhibit therein the great variety of devices manufactured by the General Incandescent Arc Light Company. They exhibit in this space arc lamps for direct constant potential circuits, Bergmann standard rack rod lamps, Bijou arc lamps, long life inclosed arc lamps, burning 100 to 150 hours, arc lamps for constant potential alternating circuits, focusing alternating arc lamps, economy coils, Bergmann switches, and a great variety of Sun-Schmelzer-Nürnberg carbons for direct and alternating currents and searchlights. Mr. R. B. Corey, the general sales agent, and Mr. L. E. Frorup preside over this exhibit.

THE AMERICAN HEATING CORPORATION, of Boston, exhibit in space 60, Section D, in conjunction with the New York Edison Illuminating Company, a great variety of cooking and heating appliances, such as street car heaters of various forms, electric vulcanizers, gluepots, boilers, portable stoves, coffee urns, plate warmers, coffee pots, tea kettles, sad irons, curling irons, heaters, ovens, chafing dishes, etc. A well illustrated catalogue is distributed, and judging by the favorable comments passed by the ladies who gather around the display in great numbers, electric cooking and heating apparatus will rapidly win popular favor as soon as the electric current becomes a general household commodity. Mr. L. L. Parsons has charge of this useful and very interesting exhibit.

THE ELECTRIC ARC LAMP COMPANY'S space is not a large one, but what it lacks in size the exhibit makes up in interest and value to the visitor. The company show various styles of their Pioneer inclosed arc lamps, and no one than the inventor himself, Mr. L. B. Marks, knows better how to point out the advantages of the Pioneer lamp. Even without the exhibit the Pioneer lamp would make a good record for itself, since a large part of the general lighting of the exposition, and quite a number of the booths, are lit by Pioneer lamps. Comments of surprise and commendation are heard on every hand, as to the beautiful quality and steadiness of the light. The absence of shadows from the globes also is the subject of general and favorable comment.

THE STANDARD PAINT COMPANY.—"Come in and have a chair, or perhaps a cigar or a boutonnière," is the happy and welcome salutation one receives on nearing the exhibit of the Standard Paint Company, who occupy spaces 38—40, Section C, Main Floor. The hospitality of the exhibitors is only equaled by the very interesting exhibit they have to present to the public. In tasteful array, in glass cases and built up in pyramidal style the well-known and indispensable "P. & B." preservative paints and insulating compounds are arranged. The company also show their P. & B. armature and field coil varnishes, insulating tape, paper, and the P. & B. ruberoid roofing. Included in the exhibit is an extended assortment of the "Ship" solid and cored carbons, manufactured by Messrs. Schiff, Jordan & Company, of Vienna, for whom the P. & B. Company are agents. Mr. F. S. De Ronde, the general sales agent of the company, is in charge of the exhibit, assisted by the genial Mr. R. L. Shainwald and Messrs. J. N. Richards and Vandewater.

THE ABENDROTH & ROOT MANUFACTURING COMPANY, of New York, have undoubtedly carried off the palm as regards boiler exhibits, having secured the privilege of the only working boiler at the exposition. The exhibit consists of a battery of two improved Root water tube-boilers, of 500 h. p., which furnishes steam to all the engine and dynamo exhibitors. The boilers are worked above their rated capacity during the entire evening, 600 h. p. being required. The unique feature about this exhibit is that it is in charge of a woman, Mrs. Helene Walten, who performs the function of lady-stoker, with great success. Mr. Albert A. Cary, superintendent of the company, is to be congratulated upon his happy idea, which is intended to emphasize the fact, that a boiler room equipped with Root boilers is not only easy of manipulation, but can be kept tidy and clean, and free from all the usual dirt and ashes, so that even a woman can take charge. The boilers are fitted with Wilkinson automatic stokers, manufactured by the Wilkinson Manufacturing Company, of Bridgeport, Pa., and are fed by a Worthington electric pump. A Hunt noiseless conveyor is also in operation, and shows how easily and conveniently the fuel can be brought from any reasonable distance to the boiler room, and the ashes conveyed out of the room to any suitable dumping place. Mrs. Walten is ably seconded in her work by Messrs. John Kallery and James Avery.

THE HEINE SAFETY BOILER COMPANY show a very fine model of a 250 horse-power boiler, illustrating the internal and external parts of the boiler very clearly. Mr. H. L. Van Zile and Mr. R. T. Walker represent the company.

NO ONE could miss the exhibit of Mr. C. H. McIntyre, for a beautiful illuminated sign "McIntyre Connectors" blazens forth from the gallery at the East end of the main hall. Various types of McIntyre connectors are shown in this exhibit, which is situated in the gallery.

THE AMERICAN CIRCULAR LOOM COMPANY, of Boston, have a small exhibit, consisting of a few coils of their well-known flexible conduit for interior wiring. The exhibit speaks for itself, though Mr. Chas. D. Doubleday is in frequent attendance to extol the merits of this type of conduit.

THE STANDARD UNDERGROUND CABLE COMPANY'S exhibit includes a general display of the products of this company, consisting of samples of their standard wires and cables, not only for underground distribution, but for general electrical purposes. The exhibit is neatly arranged on racks and tables.

THE McEWEN MANUFACTURING COMPANY have a very live exhibit in the generating department, consisting of one of their 60 horse-power high speed engines direct connected to the Thompson-Ryan 40 kilowatt dynamo. The unit operates with great smoothness and the construction of both engine and dynamo elicits much favorable comment.

THE WALKER COMPANY'S exhibit consists of an 80 kilowatt dynamo direct driven by a Phœnix 125 horse-power engine, which forms a prominent feature in the generating department; besides this machine the company also show a variety of railway equipment, consisting of motors, controllers and their standard railway switchboard panels.

NILES TOOL WORKS.—The only exhibit of heavy machine tools run by electric motors is made by the Niles Tool Works. Their exhibit includes a 37-inch boring mill run by a 3 horse-power Card motor, horizontal boring machine run by a 2½ horse-power motor, a radial drilling machine run by a 2 horse-power motor. From Mr. E. D. Becker's demonstration the visitor will readily see what a large field is open to the application of electric motors for driving machine tools.

JOHN A. ROEBLING'S SONS' CO.'S booth is decked with heavy satin curtains, and in this pleasant abode every friend receives a cordial welcome. There are on exhibition samples of the celebrated bi-metallic wire. This special department is presided over by Mr. Willard M. Miner, representing the Bi-Metallic Electric Transmission Company. All types of wires are shown in the exhibit supervised by Mr. M. R. Cockey, of the Roebling Company's New York office, and Mr. V. L. Doyle, of Trenton, N. J.

THE EXHIBIT of the Warren Electrical Co. consists of a 60 kilowatt Warren alternator, driven by a Weston engine. The alternator is so built as to generate single or two-phase currents, and allows of the taking off of 104 and 1,000 volts at the same time, completing two separate circuits from the terminals of the machine. They also have on exhibition a 45 kilowatt alternator supplying current for the whole building, the machine being of the induction type.

A. K. WARREN & COMPANY have a very interesting exhibit, devoted particularly to illustrating the repair and care of dynamos. The exhibit is a live one, as armatures are actually repaired by workmen, thus giving an apt illustration of the manner in which this work is carried out. The exhibit also includes dynamo motor brushes and brush holders, turning tools for cutting down commutators whilst in the field, and other repairing devices. Messrs. Stanmore and Warren are in attendance and are kept busy answering questions.

THE WESTON ELECTRICAL INSTRUMENT CO. show their well known types of measuring instruments. Their mascot is an 80,000 ampere station meter, showing that the company is equal to any emergency. They also exhibit a new small round pattern ammeter and voltmeter, the Van Vleck edgewise system of station indicating instruments, and a full line of laboratory standard instruments. They also exhibit a line of special alloy shunts, having negligible temperature co-efficients. Mr. A. J. Pionnie has charge of the exhibit.

THE SIMPLEX INTERIOR TELEPHONE CO., of Cincinnati, O., show their new hotel telephone and private line system, exhibited in conjunction with the Partrick & Carter annunciator. The system elicits much favorable comment. It may be used with any style of annunciator and can be attached to existing wires, obviating the necessityof rewiring. The Simplex 'phones are scattered throughout the exposition and Mr. W. L. Bradshaw, who represents the company, is kept busy answering calls and explaining the beautiful simplicity and non-infringing character of the apparatus.

THE BISHOP GUTTA-PERCHA CO. have an interesting display which has many educational features. Rubber and gutta-percha are shown in their crude state and during the various stages of manufacture. They show a full assortment of Balata wire, lamp cords, submarine and underground cables, the celebrated Marks compound and a piece of an old-time gutta-percha pipe laid in 1848 to supply Blackwell's Island with water. There is also shown a reel of copper-armored cable for lighting the main channel buoys off Sandy Hook. This interesting exhibit is in charge of Mr. Harry D. Reed.

THE PARTRIDGE CARBON COMPANY, located in the annex, exhibit a large assortment of carbon brushes for dynamos and motors, and other carbon specialties, manufactured by the firm. Though small, the exhibit is well arranged and attracts much attention.

THE RIKER ELECTRIC MOTOR COMPANY show one of their specialties—a model steam yacht lighting plant, consisting of a 5 kilowatt Riker dynamo direct driven by a Case engine. The plant is exceedingly compact and operates almost noiselessly. The exhibit also includes a number of Riker motors for power purposes, and also the Riker fan motors.

THE ANCHOR ELECTRIC COMPANY have a very handsome exhibit, in which they show samples of almost everything used in electrical supply departments. The exhibit is in charge of Mr. Field, their New York representative, though Messrs. Hawks, Reynolds and Marshall, of Boston, are frequently to be seen and appear to have a host of electrical men interested in their goods. They have a handsome electric sign in the exhibit, consisting of incandescent lamps with letters on the face, reading the name of the company. Their samples of cut-outs, rosettes, switches and general household goods are arranged with great taste.

THE WESTON ELECTRICAL INSTRUMENT COMPANY have a very comprehensive exhibit of their products, consisting of portable voltmeters, ammeters and wattmeters, covering a wide range of work; and also a complete set of their laboratory standard instruments. The front of the booth facing the historical exhibit is covered by a switchboard, upon which the Weston instruments of the dial pattern are mounted, illustrating their use in central stations and private plants. The Jumbo of the exhibit is a dial instrument indicating up to 60,000 amperes, thus showing that the company is prepared to build anything which may be called for in practical work.

THE CUTTER ELECTRIC AND MANUFACTURING COMPANY, of Philadelphia, have a very attractive exhibit, in which they show working samples of their automatic cut-outs, designed specially to take the place of fuse wire, and which they claim are much more reliable. These cut-outs are now becoming acknowledged as a most valuable device for all switchboard work, and have received the highest indorsements from electricians and electrical engineers from all over the country. They also distribute a large number of their most recent catalogue, which every station manager should procure. Messrs. Henry B. Cutter, A. E. Newton, W. E. Harrington, and Wm. Nicholson, are in constant attendance and carefully explain the merits of their goods.

GEORGE A. MACBETH & CO., the well-known glass manufacturers of Pittsburg, Pa., have a number of patterns of their "Holophanes" on exhibition, which bid fair to add fresh laurels to their wide reputation. The "Holophane" is a glass globe, the surface of which is pressed into prisms and possesses the merit of equally distributing light with but little loss of brilliancy. The efficiency of this new globe is obviously of the highest, both in incandescent and arc lighting. This firm expect to have the " Holophanes " on the market in a few days, and judging from the numerous inquiries of electric light contractors and others, the success of the globes is assured beyond a doubt. This new article is a French invention, Messrs. Macbeth & Co., holding the United States patents. They will take pleasure in sending a descriptive pamphlet of this new system of illumination to any address on application.

THE SAFETY INSULATED WIRE AND CABLE CO.'S exhibit occupies an area of 400 square feet, and forms one of the most novel and attractive features of the exposition. The booth presents the appearance of an art gallery, its walls being covered with fifteen heavy oak frames, each inclosing, to all intents and purposes, an apparently blank canvas; but presently there appear beautiful electric pictures and signs showing and telling of the company's achievements in different parts of the country. One frame contains a Western Union telegram blank, which spells out, one word at a time, an invitation to the visitors to visit the company's factory. The central sign makes the firm's name appear and disappear, and each word also changes its color. Other signs give information about cables, and smaller frames with letters of commendation are placed on easels. In connection with this unique display the railing of the space consists of sample boards on which samples of submarine, underground and aerial cables of every description are most tastefully let into the wood like mosaics. Wires for interior and out-door work, reels of various cables and wires complete the outfit of this most attractive exhibit, which is in charge of Mr. F. T. Richards, the manager of the telephone department, and Mr. LeRoy Clark, the company's electrician.

THE BUYER'S REFERENCE CO. issued a special electrical edition of their "Buyer's Reference Book." Their booth was in charge of Messrs. N. W. Gage and A. R. Curtain.

THE IRON CLAD RHEOSTAT COMPANY engaged 100 square feet of space at the exposition, but were so pushed to fill orders that they could not spare the apparatus to make an exhibit.

MR. J. S. SPEER, secretary of the Partridge Carbon Company, of Sandusky, O., was an early arrival for the convention and exposition. He reports business large and increasing all the time in their excellent carbon specialties of all kinds.

THE EXHIBIT of the Thomson Meter Co. is quite small but complete. It embraces all sizes of meters from 1 to 3-inch, inclusive, with the new straight-reading dial; also, their new meters with the new Lambert gear. The exhibit is in charge of Mr. S. D. Higby.

COLUMBIA RUBBER CO. exhibit every style of rubber goods used in the electrical line from a washer to a telephone receiver. The latest article manufactured by them is a compound composed of asbestos and other insulating materials. Their booth is very prettily decorated.

THE BABCOCK & WILCOX CO. make a good display of their boilers and parts, including sections and wrought steel plates of high pressure, sectional water tube steam boilers, a complete line of high pressure steam pipe fittings; also a very fine model complete of their forged steel sectional steam boiler.

THE GOUBERT MANUFACTURING CO.—The Goubert Manufacturing Co.'s exhibit consists of models of the Goubert feed water heater and Stratton separator. This company has the proud distinction of having a Stratton separator on every engine in the exposition generating plant and the only feed water heater used there.

THE FOREST CITY ELECTRIC CO. exhibit their celebrated roll drop and drop forged commutator bars for generators and street railway motors. The bars are tastefully arranged on boards, and the advantages claimed are admirably set forth in specimens illustrating the process of manufacture Messrs. W. B. Cleveland, and J. C. Dolph, manager of the New York office, are in charge.

THE IDEAL ELECTRIC CORPORATION, of New York, show a full line of La Roche alternators, Ideal Fleming arc lamps and focusing lamps of which they make a specialty. One of their five kilowatt alternators may be seen in operation at the booth of E. B. Latham, furnishing current for the Tuerk alternating ceiling fans and Ideal Fleming arc lamps. Messrs. F. A. La Roche and George S. Loutey are in attendance.

METROPOLITAN TELEPHONE AND TELEGRAPH CO. —A very novel and enterprising exhibit is made by this company. It consists of a model hotel pay station with monitor switchboard, showing the public graphically the business-like manner in which a pay station is run. The public as well as the exhibitors are very generously allowed to telephone about town free of charge. Mr. Samuel B. Brewster has charge of the exhibit.

MR. E. G. BERNARD, of Troy, constituted himself a walking exhibit, as it were. Though he had nothing to show, Mr. Bernard transfixed his friends by presenting them each with a box of delicious, gold-tipped, Turkish cigarettes of Jumbo size, and his friends were legion when the fact became known. Incidentally Mr. Bernard also mentioned the high grade dynamos and motors with forged fields and other latest electrical and mechanical improvements which the E. G. Bernard Company manufacture.

THE BRADFORD BELTING CO,. of Cincinnati, display a complete line of their Monarch insulating paint, which is so widely used for insulating armatures, fields, etc. Mr. Elmer P. Morris, who is in charge, never tires of applying the torch to the Monarch-painted wood and iron, but always without any damaging effect. Mr. Hubbard, of Cincinnati, was also in attendance during the first week of the exposition, and made for himself hosts of friends in the East, and left behind him a very favorable impression of the specialties of this live Western house.

THE EMPIRE SELF-LIGHTING LAMP CO. have attracted to their tastefully decorated booth large crowds who appear much interested in their self-lighting oil lamp. These lamps to all appearances are like any ordinary lamp, but require no matches or flame to light them, having concealed in their base two cells of dry battery, which by rendering a small platinum point red hot, sets flame to the wick when desired. The young lady in charge is indefatigable in her attentions, and the fact of being able to light an oil lamp, by merely turning a little thumb screw commends itself to all visitors.

DIEHL MANUFACTURING CO.—A bewildering display of ceiling fan motors is made by the Diehl Manufacturing Company. Their exhibit also contains a very full line of fancy arc lamps, and to represent their motor department they had in operation a 5 horse-power Diehl motor running a 5 horse-power Diehl generator. The booth was decorated with great taste, and the lady visitors were specially interested in watching Messrs. Knight and Bennett, who were in constant attendance, deftly manipulating a sewing machine operated by a Diehl motor, which is readily controlled by the foot of the operator.

THE COLUMBIA INCANDESCENT LAMP CO.'S exhibit is designed to demonstrate the use of the incandescent lamp in commercial, house and sign work. The latter is represented by a sign composed of over 100 lamps of ¼ candle-power, making a very attractive appearance. Those who recall the lost cause will find a melancholy interest attaching to the group of Goebel lamps, which were used as evidence in the fight between the Edison and Columbia companies. Mr. Rhotehamel, who was in charge during the convention, also explained the details of filament making by samples of the material in the various stages of manufacture, and Mr. Garrison had a pleasant mood for all callers.

THE UNITED STATES PRISM GLASS GLOBE CO. have an attractive exhibit of glass globes with prisms on the inside, which have the effect of softening and diffusing the light. It is claimed that these prism globes not only distribute more effectively than plain globes, but actually increase the effective power from 10 to 73 per cent. over other globes, besides having the appearance and beauty of cut glass. They are made in all colors, and as they emit a softened light, are of much use in hospitals and other places where nervous diseases are treated. The exhibit is in charge of Mr. A. Pond, who takes great pleasure in explaining to visitors the peculiar merits of the prism globes.

THE BRYAN-MARSH CO.'S exhibit consists of a bewildering array of lamps of all descriptions, including a solid bank of 2,000 tubular lamps, covering 26 square feet. By means of a switchboard the lamps are made to spell out in letters various political axioms and to represent figures of varying outlines. It is needless to say that a crowd is always in front of the booth, to listen to Mr. Marsh's dissertation on the value of his lamps. Not a little attention is also attracted by the illuminated curves of efficiency comparing the Bryan-Marsh with Edison lamp. The test was made by Stone & Webster, of Boston. These curves gave rise to quite a little controversial breeze between the representatives of the two companies recently, but no blood was shed.

THE PERU ELECTRIC MANUFACTURING CO. received a strong testimonial letter on the quality of their carbon for electrical purposes—as noted elsewhere. This firm have had for the past few years a steady and increasing demand for goods, owing to their superiority. Their carbons, coarse grained, open and porous, are recommended especially for sal ammoniac batteries. The well-known Laclede, also Hercules battery, are of their make. The Peru Electric Manufacturing Company's largest output, however, is in porcelain sundries, of which they turn out a full line, as well as manufacture on order. "Peru" porcelain is guaranteed of highest quality, hard burned and thoroughly vitrified. A few of their specialties are rosettes, switches, main and branch cutouts, tubes, porcelain knobs, wall receptacles, etc. Natural gas is the fuel used throughout their extensive plant. The Peru Electrical Manufacturing Company have an excellent display of their wares at the Electrical Exposition, which is at present in charge of their enterprising and genial treasurer and manager, Mr. A. H. Bouslog.

THE FORT WAYNE ELECTRIC CORPORATION occupies a space covering an area of 200 square feet. In one corner is located a switchboard with switches to control the single-phase, self-starting synchronous motors, which are the feature of their exhibit, together with voltmeters and amperemeters, and a bank of incandescent lamps. These are fed by the direct current dynamo, which is used to load the 5 horse-power single-phase alternating current motor running on the low frequency circuit of 7,200 alternations generated in the building.

One of these motors, which was described by Mr. F. H. Leonard in the paper read before the convention, is adapted for use as a rotary transformer and driven as a shunt wound direct current motor, and transforms this 110 volt direct current fed in at the commutator brushes into an alternating current of 16,000 alternations for running a 10 horse-power and a 2¼ horse-power single phase motor. A sub-station transformer of 375 lights capacity and a standard transformer of 125 lights capacity are shown together with primary fuse boxes. In the generating department, in the basement, the company has a 25 kilowatt direct connected direct current incandescent dynamo driven by a Woodbury engine.

This very attractive and complete exhibit is in charge of Messrs. F. H. Leonard, J. O. Lott and T. H. Nathans.

ONE OF THE MAIN attractions at the exhibition is that made by the United States Patent Office. It consists of models of many devices which have made fortunes for their inventors.

THE CALCULAGRAPH CO. exhibit a very complete line of their instruments, namely, those adapted for calculating, recording in hours and minutes, or dollars and cents. They demonstrate in a practical manner how the machines are used.

KEUFFEL & ESSER CO.—The only exhibit of draughting and surveying instruments is made by the well-known house of Keuffel & Esser Co. The exhibit includes an assortment of the latest drawing and surveying instruments. A complete line of field engineers' outfits, calculating machines, and the latest type of planimeters used fro figuring horse-power from indicator cars. Mr. Schildecker is in charge of their exhibit.

BALL ELECTRIC LIGHT CO.—The display made by the Ball Company, while not extensive, is quite representative in character. It consists of a 100-light, 10 ampere machine; a 50-light, 6 ampere machine, of their well known "unipolar" type. Their booth is decorated plainly, but very neatly, and the familiar face of Mr. W. J.Morrison now greets all visitors, as he has recently made connections with this company as special representative. Messrs. Charles E. Ball, J. S. Bell and J. C. Williamson are also in attendance.

THE BERNSTEIN ELECTRIC CO. have a fine display of incandescent lamps set off to advantage by the pink and white decorations. The lamps are arranged in pretty designs, and are of all colors, shapes and sizes, for multiple and series circuits. A special socket is also shown, as well as a display board illustrating the use of all alternating current street systems for incandescent lamps placed in series between the primaries of the converter. The exhibit is presided over by Messrs. H. B. Cram, J. Bradley, and Cartwright.

THE CHAPIN-DOUGLAS ELECTRIC CO. have utilized their space to excellent advantage. They show a complete direct-current switchboard fitted up with Eyanson & Armpriester switches of special design. A railway switchboard shows the Eyanson quick break switch for high tension circuits. In a neat glass case are shown the following specialties: The C-D rosette, with adjustable contacts and interchangeable caps; Burnley's soldering paste, which is non-corrosive and always plastic, needing no heat to soften it; also, the C-D incandescent lamps, and the "Perfection" dynamo brush, made of gauze, giving ventilation and reducing sparking. The exhibit is in charge of Mr. Charles E. Chapin.

A VERY PRACTICAL and instructive working exhibit is that of Henry R. Worthington, and fills a space of 200 square feet. The special features of the display are the electrically driven pumps, horizontal, vertical, duplex and triplex. There is in operation a house tank pump of 250 gallons capacity per hour, belted to and on the same bedplate with a Crocker-Wheeler motor. These pumps have already been widely introduced for house tank and similar service, and special designs have been made to cover the requirements of hydraulic elevator service, mine service, water-works supply, irrigation purposes, fire protection, or, in short, any service where electric motive power can be used to advantage. They also exhibit some of their triplex steeple power pumps, which are made up to a capacity of 1,000 gallons.

A very interesting feature is their celebrated 1½-inch test meter with special fittings. A carefully constructed model of a compound high duty pumping engine also attracts a great deal of attention. Blueprints showing the layout of water works plants, mine pumping and elevator plants are kept on file, and a very attractive special edition of their catalogue is distributed to all interested in pumping machinery and modern applications of electric power. The exhibit is in charge of Messrs. F. W. Jones and T. B. Cummings.

THE HOLTZER-CABOT ELECTRIC CO. occupy a prominent space to the left of the main entrance, and theirs is one of the coolest corners in the whole exposition, thanks to a large number of their fans in operation. They have also placed a number of their fans in other exhibits, adding largely to the comfort of visitors. Their new ceiling fan attracts a great deal of attention, both on account of its small size and attractive finish. It weighs, complete, less than 30 pounds, is but 7 inches in diameter, and consumes only 60 watts. The exhibit shows the large line which the concern carries, including bells, annunciators, clocks, and burglar alarms. The exhibit is particularly interesting on account of the large variety of special applications of motors shown, including organ-pumping combinations, emery wheels, direct driven and alternating and direct current motor generators for all kinds of service. A large line of dynamos and motors is shown. These machines, taken out of stock, show great care in construction and attention to details. The exhibit is in charge of Mr. C. E. De Lue. The Electrical Engineer is indebted to this company for the handsome fan motor which serves to keep its little space cool and comfortable even on the hottest night.

PASS & SEYMOUR, of Syracuse, have a very attractive display on the main floor. The walls of the booth are covered with all shapes and 300 sizes of glazed and unglazed tubing, insulators, china cleats, cut-outs, and cut-out insulators, rosettes, ceiling buttons, tree insulators, wire tubes, china interior conduits, window and floor tubes, carved tubes for awnings, cornices, etc., guard wire suspension insulators, branch blocks, all kinds of switches, wall socket receptacles, key and keyless sockets, junction boxes, arc hanger boards, and many more china specialties too numerous to mention. A special feature is their "Syracuse" china fixture socket, which is easily connected up, and is superior to the metal shell, it being impossible to have a short circuit with the shell or cap; they always look neat and clean. A new Edison non-infringing china base with brass contact springs is another novelty shown. In order to convince people of the superior quality of their china, they exhibit two cups and saucers, which are in no way inferior to the ware found at the festive board. Over this very neat exhibit Mr. J. D. McIntyre presides in a most able manner.

THE EXPOSITION'S CALCULATING BOY.

THE Calculagraph Company are showing at the exposition their instrument in several different applications to various businesses. As its name implies, the instrument makes calculations and renders a printed record. Those in the exhibit show, not only the time of day, but elapsed time in hours and minutes, and also in minutes and seconds. Thus if in a telephone exchange a subscriber rings up an out-of-town correspondent, this instrument shows the exact time which elapses during the telephone talk. A section of a telephone switchboard, with a Calculagraph mounted as in actual service, forms a part of the exhibit. This machine is also applicable to manufacturers, where the exact time of a workingman may be shown, or in the case of a factory employing several hands at a certain rate per hour, another instrument is devised whereby, instead of figuring the hours and minutes, or fractions thereof, during which the workingman is employed, the result at a fixed rate of payment may be shown immediately in dollars and cents. This offers to the manufacturer an economical element, in that it dispenses with a time clerk, as the machine may be operated by an office boy, or by the workingmen themselves. But probably the most interesting variation of this device is shown in that form which is used in the hiring of row boats, horses or bicycles, for example, where the charge for service is a certain figure for the first hour and then something less than that for every hour thereafter. This machine is so adjusted that it automatically indicates the maximum charge for the first hour, and the minimum charge for the succeeding period, printing the result immediately in dollars and cents, in such a manner as to remove all possibility of mistake. It is a cleverly contrived piece of work and has attracted much attention to the space occupied by this company, which in itself is tastefully decorated with curtains and furnished with easy chairs.

PERSONAL.

MR. FRANCIS W. JONES, electrician of the Postal-Telegraph Cable Company, has contributed to the last monthly number of the "Transactions of the American Institute of Electrical Engineers," a most charming tribute to the memory of his old friend, Franklin Leonard Pope. It is written from the standpoint of close personal friendship, yet is impartial and even in its judgment and review. One may hunt long for a better piece of terse and sympathetic biographical work.

MR. HERBERT LAWS WEBB has in the "Illustrated American" of May 6 an admirable illustrated article on "The Switchboards of New York," being an account of what has been done to build up and maintain the telephone system of this city.

MR. HENRY G. ISSERTEL, E. E., has been appointed on the faculty of the National College of Electro-Therapeutics, at Indianapolis, Ind., in the chair of Practical Dynamic Electricity, a branch with which he is very familiar.

PROF. E. P. ROBERTS, of the Correspondence School of Technology, Cleveland, has been appointed consulting electrical engineer for an electric light plant to be installed in the Columbus State Hospital.

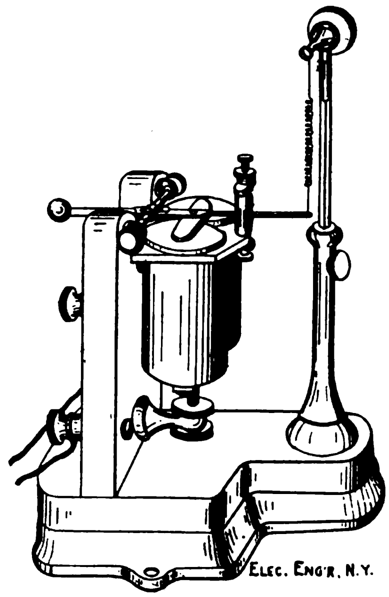
DR. WM. H. WAHL, for many years resident secretary of the Franklin Institute, has been honored by the French Government by election as "Officier d'Académie" with the decoration of the "palmes académiques" in recognition of his labors as secretary of the leading institute in America devoted to the advancement of the arts and manufactures, and of services rendered to the French Government.

TELEPHONY AND TELEGRAPHY.

EXPERIMENTS WITH MAC DONALD'S SENSITIVE-RELAY.

BY EDWARD P. THOMPSON, M. E.

THE instrument employed in these experiments is represented in the accompanying engraving, and consists of the ordinary Morse relay, except that the same is tilted so as to stand upright, while the tension spring is vertically set above one end of the armature lever, a weight being on the other, while the armature is between the spring and the fulcrum. Mr. A. D. MacDonald, of the Government Central



THE MAC DONALD SENSITIVE RELAY.

Telegraph Office, Melbourne, Australia, has communicated to me, for publication, the minutest details, description of the apparatus and the results, and I submit the following brief account which may be of interest to those interested in telegraphy. The tests were made on a line between Melbourne and Sydney, a distance of 577 miles, measured resistance 3,200 ohms, to which another 3,000 ohms was added, making a total of 6,200 ohms, equivalent to 1,100 miles of wire. The usual batteries were replaced by only one Leclanché cell, and the relay was wound to only 150 ohms of No. 32 wire. The weather was so unfavorable at the time that business had been delayed with the ordinary relays. Similar experiments were also carried on in the presence of Mr. Dwyer, officer in charge of the night staff, and operators Wulff, Healy and Bowe, and M. J. Cawley, testing officer. Telegraphic communication was held between Melbourne and Adelaide, as well as between Sydney and Melbourne, with perfect success.

PETITION AGAINST THE NEW CABLE VOCABULARY.

A petition is in circulation in this city asking for a reconsideration of the proposed official code vocabulary issued by the International Telegraph Bureau, at Berne. Following are some of the objections to the enforced adoption of the vocabulary: (1) The inadequate number of ciphers; (2) conflicting character of very many of the ciphers; (3) absence of necessity for changing existing conditions; (4) strong objection by financial and commercial bodies, bankers and merchants to adoption; (5) enormous expense attending revision of present cable codes; (6) apparent attempt to increase cost of cabling while limiting preconcerted ciphers to the number proposed; (7) wrong impression created by issuing the publication, many believing that the book is a complete code instead of a compilation of ciphers; (8) existing restrictions are sufficient to overcome attempts at irregularity on the part of merchants; (9) the use of names of common commercial articles, names representing days of week and name of months, of coins, of numerals, etc.

SOCIETY AND CLUB NOTES.

ANNUAL MEETING OF THE A. I. E. E.

The annual meeting of the Institute took place this week at the Electrical Exposition, where headquarters were furnished by the management. The business meeting for reports and election of officers took place on Tuesday. The following programme was arranged for Wednesday:

1. Teller's report of ballots received.
2. Report of Sub-Committee on Standards of Lights, by Dr. Edward L. Nichols, Clayton H. Sharp and Charles P. Matthews, of Ithaca, N. Y. A complete résumé of existing data upon this subject, together with original work by the committee, embracing standard candles, the Methven screen, the Pentane standard Hefner lamp, platinum standards, the Blondel arc standard, kerosene lamps, the acetylene flame, incandescent oxides, etc.
3. "Vacuum Tube Lighting." An opportunity will be offered for the discussion of the paper by Mr. D. McFarlan Moore, presented April 22.
4. "An Analysis of Transformer Curves," by Charles K. Huguet, of Pittsburg.

AFTERNOON SESSION.

Two o'clock, Wednesday, May 20, 1896.

5. "Effect of Temperature on Insulating Material," by George F. Sever, Ambrose Monell, and C. Langdon Perry, of New York City.
6. "An Experimental Study of Electromotive Forces Induced on Breaking a Circuit," by F. J. A. McKittrick, with introduction by Dr. E. L. Nichols, of Ithaca, N. Y.
7. "The Production of Electrical Energy for Office Buildings with Particular Reference to the Plant of the Chicago Board of Trade," by Bion J. Arnold, of Chicago.

THE NEW YORK ELECTRICAL SOCIETY AT THE EXPOSITION.

The 175th meeting of the society was held at the exposition on Monday, May 18, at 8 p. m., when the annual election of officers took place.

President Lieb received the members in the lecture room on the third story, after which special facilities were given for inspecting the chief features of interest, including a private view of the Edison fluoroscope and Röntgen ray exhibit.

Members and their friends wore the red and white badge on this occasion, distributed in the lecture room by the reception committee. There was a large attendance.

The ticket presented for election was as follows: President, Dr. C. E. Emery; vice-presidents H. L. Webb, W. W. Ker, Gano S. Dunn, M. Osterberg, A. L. Riker, W. Finn; treasurer, H. A. Sinclair; secretary, G. H. Guy. The society has had a most prosperous year, and now has close on to four hundred members.

REPORTS OF COMPANIES.

GENERAL ELECTRIC'S ANNUAL MEETING.

The annual meeting of the stockholders of the General Electrice Company was held at Schenectady on May 12. About 200,000 shares were represented. The directors elected are the same as last year, except that George Foster Peabody takes the place of Thomas K. Cummins, Jr. The board for the ensuing year is Oliver Ames, second, T. Jefferson Coolidge, Jr., C. H. Coster, Thomas A. Edison, Eugene Griffin, Gordon Abbott, F. B. Hastings, Henry L. Higginson, George P. Gardner, J. Pierpont Morgan, Robert Treat Paine, second, George Foster Peabody and C. A. Coffin.

INTERNATIONAL BELL TELEPHONE CO.

The annual meeting for the election of a board of directors to serve during the ensuing year was held May 12 by the stockholders of the International Bell Telephone Company (Limited), New York City. The following were chosen: Samuel D. Babcock, Gardiner G. Hubbard, Louis A. Von Hoffmann, Richard A. McCurdy, Charlton T. Lewis, Elisha S. Converse, William Mertens, Howard S. Randall and Louis A. Thebaud.

HELENA, MONT.—About $800,000 is to be spent in developing power electrically from the Missouri for Helena. President Hauser, of the First National Bank, and President Marlow, of the Montana National Bank, are interested.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS ISSUED APRIL 28, 1896.

Alarms and Signals:—

AUTOMATIC ELECTRIC INDICATOR SYSTEM. G. E. Painter, Baltimore, Md., 559,088. Filed Feb. 26, 1895.
An armature lever serving as a switch arm, and provided with reversely inclined faces, an arm having similarly inclined faces for engaging with those on the lever, and operating as a tripping device, for mechanically moving said lever, and for confining it except when actuated by its magnets.

ELECTRICAL SIGNALING APPARATUS. G. E. Painter, Baltimore, Md., 559,089. Filed Feb. 16, 1895.
Similar to above.

SIGNALING APPARATUS FOR PRESSURE GAUGES. T. M. Gordon, Boston, Mass., 559,131. Filed July 10, 1895.
Details of Construction.

PROCESS OF HARDENING POSITIVE MASSES OF ACCUMULATORS. O. H. Weise, Poessnick, Germany, 559,155. Filed July 13, 1895.
Consists in placing the completed lead superoxid plate into a bath of glycerin.

Conductors, Conduits and Insulators:—

ELECTRIC CONNECTION. J. W. Marsh, Pittsburg, Pa., 558,971. Filed May 6, 1895.
A protecting covering, having mica compound or similar moldable insulating material molded directly to one or both of the members to form a tight joint.

CONNECTOR FOR ELECTRICITY CARRYING CABLES. D. E. Evans, Baltimore, Md., 559,168. Filed Nov. 4, 1895.
A tubular shell, enlarged centrally and provided with longitudinally disposed slots extending through opposite sides of the enlarged central portion, and means for fastening the ends of cables and soldering them together.

Distribution:—

MULTIPLE SERIES SYSTEM OF ELECTRICAL DISTRIBUTION. F. B. Badt, Chicago, Ill., 558,924. Filed Sept. 25, 1895.
Translating devices connected in multiple series between main and compensating conductors, an auxiliary source of electricity, an electrically operated controlling switch for connecting said source of electricity in circuit upon one or the other of the sides of said system, and a relay for automatically controlling the circuit through said controlling switch.

Dynamos and Motors:—

CURRENT STRAIGHTENING COMMUTATOR. C. Pollak, Frankfurt-on-the-Main, Germany, 558,983. Filed Aug. 28, 1895.
The combination of insulated hubs, having alternated segments and sleeve secured to the shaft between the hubs and to said hubs to hold the latter in place, said sleeve being insulated from the hubs.

ELECTRIC TRACTION MOTOR. J. F. Place, Montclair, N. J., 559,342. Filed March 16, 1894.
An aerial track motor for towing boats.

Electro-Metallurgy:—

METHOD OF ELECTROPLATING PURE NICKEL FROM FERRO-NICKEL ANODES. D. H. Browne, Brooklyn, O., 559,255. Filed July 20, 1893.
Consists in adding ammonia to the nickel salt solution until the latter is perceptibly smelling of ammonia, passing the current through the anodes, solution and cathodes, and introducing air in comminuted condition through the solution.

Lamps and Appurtenances:—

HANGER FOR ARC LAMPS. L. A. Scovil, Chicago, Ill., 558,989. Filed March 28, 1893.
A sleeve, a rod adapted to enter said sleeve, a lug or tongue being provided upon one of said parts while a longitudinal slot with inclined surfaces leading thereto is provided upon the other of said parts.

SAFETY ARC LAMP HANGER. E. P. Snowden, St. Joseph, Mo., 558,993. Filed Feb. 11, 1896.
Details of Construction.

ELECTRIC RUNNING LIGHT AND SIGNAL LANTERN FOR SHIPS. J. Barre, New York, 559,048. Filed Nov. 29, 1893.
Is provided with a cap at its upper end, carrying supports for two or more electric lights, said cap being rotatable with respect to the lamp fixture, whereby the electric lights may be brought successively into focus.

MAST ARM FOR ELECTRIC LAMPS. J. J. Shickluna, Buffalo, N. Y., 559,066. Filed April 29, 1895.
Composed of adjustable sections.

ELECTRIC LIGHT AND SIGNALING DEVICE. D. Misell, New York, 559,143. Filed Feb. 25, 1896.
The use of a spring-actuated circuit-maker which serves the double purpose of a handle for carrying the device, and a switch for controlling the current.

ELECTRIC LIGHT SHADE. H. Stenz, Faribault, Minn., 559,149. Filed June 27, 1895.
Comprises a clasp member for engaging the lamp, the shade member hinged directly to the clasp member and an arm to adjust the angle of the shade.

SOCKET FOR INCANDESCENT LAMPS. J. C. Tournier, Schenectady, N. Y., 559,232. Filed March 25, 1896.
Details of construction.

ELECTRIC LAMP. R. Hacking and G. Brand, Nottingham, England, 559,282. Filed July 20, 1895.
A combined protector and reflector axially rotatable upon the base piece.

Measurement:—

MILLIAMPERE METER. C. M. Hollopeter, Fostoria, O., 559,134. Filed May 31, 1895.
Especially adapted for the measurement of galvanic currents.

Miscellaneous:—

METHOD OF ELECTROLYTIC TREATMENT OF SOAP LYES. O. Lugo and H. T. Jackson, New York, 558,970. Filed Oct. 4, 1895.
The process of extracting the caustic alkali from spent soap lyes, which consists in subjecting the liquor to the action of a current of electricity applied by means of an anode of zinc retained in contact with the liquor, and a cathode separated from the anode by a porous partition.

ENDOSCOPIC INSTRUMENT. J. W. Daily, Boston, Mass., 559,122. Filed Aug. 21, 1895.
Consists of a detachable removable tube inclosing a small incandescent electric lamp.

MAGNETIZING BOX FOR HAIR PINS. C. A. Hussey, New York, 559,176. Filed Aug. 22, 1895.
A box having a form supporting the hair pins and a magnetized metallic part adapted to magnetize the hair pins.

ELECTRIC ATTACHMENT FOR PAPER RULING MACHINES. J. McAdams, Brooklyn, N. Y., 559,190. Filed Feb. 8, 1896.
Details of construction.

ELECTRIC BOILER. F. W. Schindler-Jenny, Kennelbach, Austria-Hungary, 559,223. Filed Oct. 2, 1895.
A ring-shaped heating body of refractory insulating material, containing resistance wires, and a casing in close contact with the said heating body.

ELECTRICALLY CONTROLLED CLUTCH. F. A. Weller, Boston, Mass., 559,240. Filed April 20, 1892.
A spanner co-operating with the screw to move the clutch and an electromagnet for moving the spanner into engagement with the screw.

ELECTRIC HEEL AND TOE PROTECTOR. J. A. Blair, New York, 559,254. Filed Feb. 27, 1896.
Consists of a heel socket and toe socket connected by elastic bands and separately containing positive and negative elements connected by a conductor.

PLOWING BY ELECTRICITY. F. Brutschke, Charlottenburg, Germany, 559,256. Filed Jan. 2, 1895.
A balanced tipping plow having an electric motor mounted thereon and a chain wheel actuated by the motor, in combination with a chain to be stretched across a field and anchored.

CANAL BOAT PROPULSION. W. Elmer, Jr., Trenton, N. J., 559,271. Filed Dec. 16, 1895.
An electric motor mounted on a movable truck is employed to operate a shaft having a sheave engaging with a traction cable.

CONTROLLING MECHANISM FOR LOCKS. R. A. Palmer, Boston, Mass., 559,308. Filed Aug. 14, 1895.
Employs a two-part spindle to operate by electromagnets.

Railways and Appliances:—

ECCENTRIC MOUNTING FOR ELECTRIC VEHICLE AXLES. E. W. G. C. Hoffmann, Charlottenburg, Germany, 558,953. Filed Dec. 27, 1895.
Details of Construction.

ELECTRIC RAILWAY CONDUIT. J. H. Munson, Chicago, Ill., 559,105. Filed March 5, 1895.
A slotted conduit having a recess or chamber, an insulating lining therefor, a metallic lining within the same, a plunger slidable within said metallic lining or barrel, and contact and switch devices provided in connection with said plunger.

ELECTRIC RAILWAY. R. M. Hunter, Philadelphia, Pa., 559,175. Filed July 8, 1893.

TROLLEY FOR ELECTRIC CARS. J. L. Foster, Waterbury, Conn., 559,275. Filed Sept. 11, 1895.
Means for lowering trolley when connection with the conductor is broken.

Regulation:—

ELECTRIC GOVERNOR. K. B. Miller, Washington, D. C., 559,187. Filed Feb. 25, 1896.
Consists in generating a periodic current and causing changes in the period of said current to react on the source of supply of power.

Switches, Cut-Outs, etc.

CIRCUIT BREAKER. M. J. Griffith, Wilkesbarre, Pa., 559,280. Filed Aug. 28, 1895.
Employs two pairs of contact pieces, one pair provided with carbon terminals and the other with metallic; and means are provided to separate the contact pieces suddenly and one after the other.

COMBINED SWITCH AND FUSE BLOCK. E. H. Montgomery, St. Paul, Minn., 559,340. Filed Oct. 2, 1893.
Consists of a rotatable block mounted upon a base, with suitable binding posts and circuit terminals for the line wires and dynamos.

Telephones:—

TELEPHONE AND CALLING SYSTEM. C. B. Smith, New York, 559,086. Filed Nov. 18, 1895.
Each conductor is normally apportioned to one station; calling devices and indicators or annunciators in each station.

TELEPHONE AND CALLING SYSTEM. C. B. Smith, New York, 559,087. Filed Nov. 19, 1895.
Similar to above.

TELEPHONE AND CALLING SYSTEM. J. G. Smith, New York, 559,088. Filed Feb. 11, 1896.
Similar to above.

TELEPHONE TRANSMITTER. F. A. Ray, Springfield, O., 559,106. Filed Oct. 2, 1893.
Pairs of diaphragms, comminuted resistance varying material mounted between and supported directly by said diaphragms, a cell containing said comminuted material, a single mouthpiece and air passages between said mouthpiece and each of said diaphragms.

ART OF TELEPHONING. D. H. Fitch, Cazenovia, N. Y., 559,274. Filed Nov. 29, 1895.
A normally polarized electromagnet, an auxiliary mechanism actuated thereby, and a multiple connection between the magnet coils and line terminals.

TELEPHONE SWITCHBOARD. H. M. Fisk, Austin, Ill., 559,348. Filed May 27, 1895.
Combination of an electromagnet and a drop or shutter in front of it with connecting or extension points in front of the shutter, and a thin plug attached to a flexible cord and made to lock into the connectors.

ELECTRICITY IN A BROOKLYN HOSPITAL.

The Long Island College Hospital will have in its new Polhemus Memorial Building a course of study in electro-therapeutics, to be carried on with the aid of the latest and best apparatus.

Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

THE PROSPERITY OF THE TRIUMPH ELECTRIC COMPANY.

The Triumph Electric Company, of Cincinnati, issues the following list of its April business:

Caledonia Electric Light and Power Company, Owosso, Mich., one 150 kilowatt, 550 volt generator, direct connected to a Fischer engine. Owosso and Corunna Traction Company, Owosso, Mich., two 65 kilowatt, 550 volt generators, belted. Lane & Bodley Company, Cincinnati, O., one 100 kilowatt belted generator. Studebaker Bros. Manufacturing Company, South Bend, Ind., one 65 kilowatt belted generator. Hot Springs Hotel Company, Hot Springs, Va., one 55 kilowatt generator direct connected to Buckeye engine; one 30 kilowatt belted generator. Krippendorf, Dittman & Company, Cincinnati, O., two 65 kilowatt generators direct connected to a Willans engine. J. M. High & Company, Atlanta, Ga., one 45 kilowatt belted generator. U. S. snag boat "E. A. Woodruff," Cincinnati, O., one 10 kilowatt generator direct connected to vertical engine. A. H. Ely, New York City, one 80 kilowatt type W generator direct connected to an Ames engine. Sol. Sayles, New York City, one 25 kilowatt generator direct connected to a Woodbury engine. Nordberg Manufacturing Company, Milwaukee, Wis., one 30 kilowatt generator belted.

THE NEW C & C MULTIPOLAR DYNAMO.

We illustrate in the accompanying engravings the new type of multipolar generator built by the C. & C. Electric Company, of New York, which has been designed in accordance with the most approved electrical practice and with special reference to direct connection with the driving engine. With this end in view the design of the machine has been such that the dynamo can be driven direct by the best class of engines in contradistinction to a design which just barely permits of the machine being connected to engines running at very high speeds.

As will be seen, the simplest mechanical construction has been adopted. The entire field magnet frame, including the pole pieces, is cast in one piece, of steel, without a single joint, and the magnetic leakage is so low that no magnetism can be found in the iron of the engine. This avoids the baneful effects of stray magnetism which is frequently found to affect the operation of the engine governor.

Each field coil is independently wound on a separate, detachable bobbin, so constructed to be open to air currents, both inside as well as outside, and as a result the regulation is not appreciably affected by any variation of the resistance of the coils during a run, no matter how long; besides, with this construction the field is economical, and a burnout practically impossible.

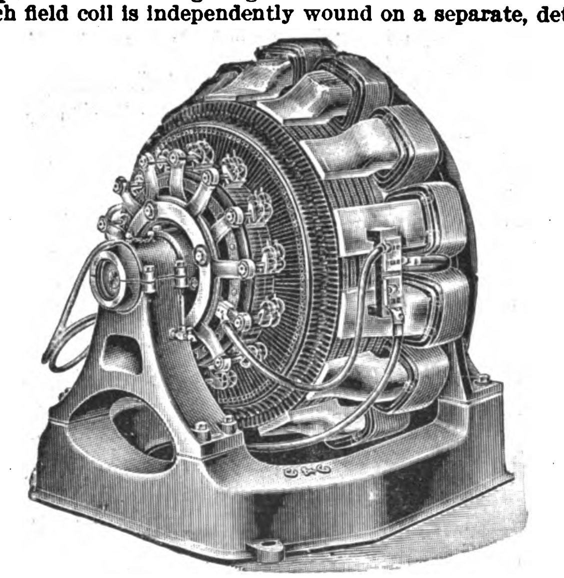


FIG. 1.—THE NEW C & C MULTIPOLAR DYNAMO.

The armature is wound with endless flat ribbons or bars, thus reducing the air gap to a minimum and guaranteeing windings against slip, at the same time allowing of easy rewinding of a coil, in case of necessity, by even a novice.

The brushes employed are of graphite, and thus self-lubricating, which, as is well known, is only possible in a dynamo where the current is of low density in each brush, such as is the case in this type of machine; the result of this practice is that the commutator does not cut or wear.

Particular care has been bestowed upon the ventilation of the machine, and as a result even under the usual practice of overloading, the machine runs cool, and a heavy emergency overload can be carried with safety. The insulation of the machine is one million ohms from conductor to frame.

The regulation of the machine is automatic within less than 2 per cent. with extreme variations of load. No brush movement whatever is required up to an overload of 20 per cent. The commercial efficiency of the machine is from 90 to 95 per cent., depending on the size of the machine, which efficiency is maintained nearly throughout the entire working range of

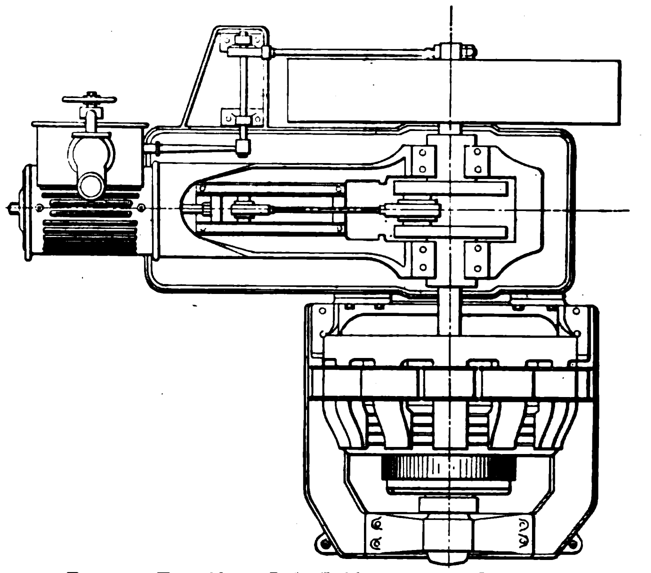


FIG. 2.—THE NEW C & C MULTIPOLAR DYNAMO.

load. These machines are built in sizes of 25, 50 and 100 kilowatts. Our engraving, Fig. 1, shows the dynamo in perspective, and Fig. 2 is a plan view illustrating its connection direct to the engine. It will be noted that no outboard bearing is required, thus economizing space and reducing the cost.

3,600 H. P. FEED WATER HEATERS.

The Kensington Engine Works, Limited, of Philadelphia, Pa., have just closed a contract with the William Cramp & Sons Ship and Engine Building Company, for two of their large water tube heaters. They will be 38 inches in diameter by 20 feet long, and tested for a working pressure of 150 pounds. These heaters will be installed in the power plant at Washington, D. C., for the electric trolley line between Baltimore and Washington.

FREE CUBA.

There is no need to go to Cuba to ascertain all the facts as to the war for freedom in the ever-rebellious isle. All you have to do is to secure the latest advertising card of the American Electrical Works, of Providence, R. I. It gives all the data in a pretty and effective way.

INTERIOR TELEPHONES AT NARRAGANSETT PIER, R. I.

What is said to be the largest interior telephone system in the world is being installed by the Wilson Bates Electric Company for the Hotel Matthewson, Narragansett Pier, R. I. The telephones for this work are being furnished by De Veau & Co., of 32 and 34 Frankfort street, New York City.

BORING STEAMBOAT ENGINE CYLINDERS BY ELECTRIC MOTOR.

The Vulcan Iron Works Company, of Toledo, O., Alex. Backus, president, recently performed a very rapid piece of work on a steamship with the aid of an electric motor, in the way of boring the cylinders. They used a one horse-power

Commercial Electric Company, Indianapolis, Ind., 500-volt motor, the speed of which is 2,200. The bar was geared back from this thirty-six times. They bored one 48-inch diameter cylinder 42 inches deep in 9 hours; one 30 inches by 42 inches in 7½ hours; one air pump, 20 inches by 24 inches, two cuts, in 5 hours; one steam chest, 14 inches by 44 inches, in 5½ hours; one steam chest, 12 inches by 34 inches, in 3½ hours. The motor gave them a very steady motion and enabled them to make a perfect job. It is one that attracted considerable attention here, and the firm have received very favorable comment on the work. The work was done on the Wabash Line Steamer S. C. Reynolds.

NEW DEPARTURE IN AUTOMATIC FIRE ALARMS.

The Electric Heat Alarm Company, 145 High street, Boston, Mass., has brought its thermostat to a very high degree of perfection. It has been installed in direct connection with street fire alarm boxes for over a year without trouble, the latest connections having been made at Rockland and East Weymouth, Mass. In this unique system the transmitter in the testing and recording apparatus is connected in series with the fire alarm boxes, and made to strike a certain number, like the street fire alarm system. In connection with this is a box on the outside of the building. Should a fire occur in the immediate vicinity of the factory after it is closed, a person discovering the fire can by the simple act of breaking the glass in this box give an alarm to the department. The department immediately know that there is a fire in the factory or nearby. When they arrive at the factory and find that the bell on the front of the building is not ringing, and the annunciator drop not indicating a certain section of the factory, they know that the fire is in some house nearby. This practically gives the town another street fire alarm box, and as most villages have only a few boxes, the system is highly appreciated by the citizens.

The Electric Heat Alarm Company is making arrangements for connecting this system direct with a successive non-interference fire alarm box made by the United States Fire and Police Telegraph Company, of 246 Washington street, Boston.

The Electric Heat Alarm Company would be pleased to have parties interested call and see the practical working of its system.

From firms in Bangor, Maine, and Milford, N. H., most flattering indorsements have been received, of this system, which is so unerring in its operation. Below is a copy of a letter received from Morse & Kaley Manufacturing Company, Milford, N. H., which speaks for itself:

Milford, N. H., February 18, 1896.

Electric Heat Alarm Company, Boston, Mass.

We wish to pay our tribute to your Thermostat Fire Alarm. We had a slight fire in our balling room last night and it worked to a charm, as it went off before the sprinklers, thus allowing time for our men to get there to prevent unnecessary damage by water. We congratulate you on its successful workings.

Yours very truly,
(Signed) MORSE & KALEY MFG. CO.
Dic. by F. E. K.

ELECTRICITY IN PENNSYLVANIA MINES.

One of the most recent coal mine plants is that which will be installed by the Scranton Electrical Construction Company at the Mount Pleasant Colliery, owned by Mr. W. F. Smith, of Scranton. The electrical portion of the plant will consist of one four-pole 100 kilowatt, 650 revolution, 250 volt generator, and one electric locomotive from the works of the General Electric Company. The locomotive will be required to haul an average of about 400 cars daily from the counter chutes located along the main gangway. The average length of haul one way is about 3,000 feet. In addition to the haulage plant the coal company will operate from the same wire several rotary coal drills in the same vein.

Another interesting electrical plant is being installed by the Lehigh Valley Coal Company, which operates a large number of collieries in the anthracite district as well as many semi-bituminous mines in the Clearfield region. The plant consists of one General Electric 150 kilowatt, 550 volt generator furnishing current to one duplex double acting Jeansville mine pump, and one 100 horse-power Lidgerwood friction cone clutch single drum hoist. Both of these machines will be set about 6,000 feet from the generator in the center of a long slope in the main coal seam. The circuit to the hoist and pump will be carried about 5,300 feet above ground on a pole line, and will then pass down a vertical bore hole 350 feet deep. This part of the line will consist of an iron armored cable, and will be suspended solely by the iron armor.

The pump will have a capacity of 600 gallons per minute, and will lift water through a vertical bore hole to a height of 350 feet. The average work of the hoist will be the hauling of about fifteen tons up an 8 degree slope at an average speed of 500 feet. The hoist will also be required to lower about five tons down the same slope. The advantages of electricity are strikingly illustrated in this plant. If electricity had not been selected for the hoist and pump work, it would have been necessary to carry the steam some distance through the mine, and provide special bore holes and condensers for the disposition of the exhaust steam.

A TELEPHONE PLANT FOR FORT WAYNE, IND.

The Western Telephone Construction Company has just closed a contract with the Fort Wayne Telephone Company, Fort Wayne, Ind., to furnish a 2,000 equipment, 1,000 of which are to be shipped immediately. This is to be the "Queen" independent telephone exchange system in America.

UNDERGROUND CABLE EXPERTS.

Mr. William Arnot, Mr. Philip Martin, Mr. Michael Duffy, and Mr. John McKenna, well-known underground cable experts, have resigned from the Standard Company and have made arrangements with the National Underground Cable Company. Each of these men has had a long experience in underground and aerial cable construction work of all kinds, including street railway, electric light, telephone and telegraph cable, and are well known for their ability in their lines and are a valuable addition to the National Company's already large force.

The National Company's Construction Department is now one of the largest in the country and is in a position to handle any work, no matter how large, with promptness and dispatch.

THE HOGAN BOILER COMPANY.

The Hogan Boiler Company have published a pamphlet in which the excellent points of their water tube boilers, stationary and marine, are set forth. "Six reasons" are given why the Hogan water tube boilers deliver dry steam, and do not "prime" or foam. Each steam producing tube passes above the water surface in the steam drum; the effect of ebullition is removed from beneath the water surface; water cannot be entrained with the steam through the perforated plates of the steam extractor; small globules of water within the steam extractor are evaporated; the extractor is located in the steam drum where the highest temperatures exist; and the steam separators are not necessary with the Hogan water tube boilers. The company claim that in using their boilers there is no scale on the heating surface, the mud drums collect all the sediment, the efficiency is increased greatly above the normal, and the yearly coal bills are reduced by thousands of dollars.

THE ALUMINUM FLUOROSCOPE.

Mr. Henry V. Parsell, Jr., writes us as follows:

I have tried the aluminum fluoroscope, and should judge that it is about three-quarters (¾) as effective as the Aylsworth & Jackson instrument. There is an irregularity in the luminosity of the screen. To make sure I have tried several other observers who agree with me in the foregoing statements.

CARD GENERATOR FOR THE OHIO STATE REFORMATORY.

The board of managers of the Ohio State Reformatory have awarded the Card Electric Company, of Mansfield, O., the contract for two direct connected multipolar generators, capacity 66 k. w. each, speed 250 revolutions per minute, for use in the reformatory at Mansfield, for lighting purposes. The generators will be direct coupled to Ball engines. Competition in the above case was quite keen, and the company consider the capture of the contract quite an achievement.

MR. M. M. WOOD, the well-known electrical engineer, of Chicago, Ill., has completed the long-distance transmission power plant for the Lowell Water and Light Co., of Grand Rapids, and the company may congratulate themselves in having employed so good a man to engineer their work. Mr. Wood has the reputation of being among the best as an engineer, and it is with pleasure we credit him with constructing the third longest power transmission in the United States, that from Lowell to Grand Rapids, Mich, a distance of twenty miles, and delivering 200 horse-power.

NEW ENGLAND NOTES.

MR. C. G. PERKINS, President of the Perkins Electric Switch Manufacturing Company, Hartford, Conn., made a short business trip to Chicago recently, and made his headquarters at the Western Office of the company, in the Monadnock Block.

GEO. H. MORRILL & CO., of Boston, Mass., manufacturers of printers' inks, are erecting a building over some new stills in addition to their already extensive plant. This building will be of steel construction throughout, having steel siding, roof trusses and covering, and the interior platforms will be constructed in the same manner. The Berlin Iron Bridge Company, of East Berlin, Conn., have the contract for furnishing the complete building.

WESTERN NOTES.

THE LAKON CO., manufacturers of the Lakon transformer, have removed their Chicago office, which is in charge of F. S. Terry, to suite 1,509, 1,510 and 1,5011 Monadnock Block.

THE SUNBEAM INCANDESCENT LAMP CO., Chicago, have removed their offices from the Title and Trust Building to suite Nos. 1,509, 1,510 and 1,511 Monadnock Block, where they will have much more commodious quarters.

THE CUTTER ELECTRICAL AND MANUFACTURING CO., manufacturers of the C. S. flush push switches and the I. T. E. circuit breakers, have removed their western office to suite No. 1,509, 1,510 and 1,511 Monadnock Block, Chicago.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, of St. Louis, have issued recently two neat and business-like catalogues, one relating to their transformers and the other to their switchboards. Both are full of data, cuts and appropriate information.

MR. S. F. B. MORSE, the Marquette Building, Chicago, General Western Agent for Day's Kerite, recently secured the contract for the wiring of the new Great Northern Hotel and Theatre with the well-known Kerite wire. As usual there was some brisk competition for the contract, and after a sharp fight of considerable duration Kerite came to the fore.

THE METROPOLITAN ELECTRIC COMPANY have just taken the agency for the Diehl Manufacturing Company, of Elizabethport, New Jersey, and will carry in stock a complete line of their ceiling fan motors. The Diehl Manufacturing Company are the oldest manufacturers in the country of ceiling fan motors in their various shapes and styles, and the Metropolitan Electric Company are fortunate in securing this agency.

THE ELECTRICAL APPLIANCE COMPANY, Chicago, state that they are well prepared for the fan motor season with a very complete line. They still retain the agency for the celebrated Meston line of alternating current apparatus. The agency for the celebrated Dayton ceiling and column fan has been secured for this season. The new Acme fan motor manufactured by the Appliance Company will also be a specialty for this season. It is made in both single and three speed and is a high grade machine.

MR. JOHN GORMAN, for twenty years practical electrician and dealer in electrical apparatus in St. Paul, will represent the Metropolitan Electric Company in handling N. I. R. wire, Metropolitan lamps, "Mac" tape, P. & B. Compound varnish, etc. Mr. Gorman is prominently identified in electrical interests in St. Paul and Minneapolis, and has done a large share of the electrical work in that section during the last twenty years. The Metropolitan Company can be congratulated in getting Mr. Gorman to handle their goods.

THE AKRON SMOKING PIPE COMPANY, of Akron, O., are now manufacturing Fenton insulating tubes, cleats and knobs in a variety of sizes to meet the demands. These goods are composed of a hard, vitreous substance, uniformly glazed, which the company thoroughly warrants in regard to absorbtion and conductivity. The process of manufacture employed by this company enables them to produce perfect shapes of any length, and tubes of large dimensions will be guaranteed as to their straightness. Tubes are made with white or brown glaze or of porcelain.

THE TRUMP MANUFACTURING COMPANY, of Springfield, O., issue a large and handsome pamphlet devoted to their Trump model turbine, which is in widespread use, and is an effective piece of apparatus for the utilization of water-power. The pamphlet contains illustrations of its use. The company build also the Leffel wheel in all sizes, and the double discharge turbine peculiarly suitable for high heads. They are also largely engaged in the production of penstocks, piping, etc., mill gearing, shafting, etc. The class of work is important, and the grade is of the highest.

THE FARR TELEPHONE AND CONSTRUCTION SUPPLY COMPANY, 342 Dearborn street, Chicago, are now distributing their latest catalogue, which is the third and largest that has been published by this enterprising concern. It is very tastefully done, with a bright paper cover, on the front of which is shown a view of the exterior of the company's store. The catalogue contains thirty-two pages of illustrations and reading matter pertaining to the large and varied stock of telephone goods which they carry. As the prices of all the goods are mentioned, and also full particulars regarding terms are given in a very lucid manner, all who are interested in telephone matters will find it a most convenient book to have at hand.

NEW YORK NOTES.

THE WARD LEONARD ELECTRIC CO. will make various kinds of electrical apparatus at Hoboken, N. J. Its capital stock is $100,000. Among those interested are H. Ward Leonard, W. Pelzer and D. H. Driscoll.

THE VITASCOPE COMPANY, of New York City, has been formed to deal in vitascopes, kinetoscopes, phonographs, and similar machines. Capital, $60,000, and directors: Norman C. Raff, Frank R. Gammon and James H. White, of Brooklyn.

MR. F. W. DARLINGTON, formerly chief engineer for the Philadelphia Traction Company, having offices at the Drexel Building, Philadelphia, and 111 Broadway, New York, has removed the latter office to 114 Nassau street, New York. Mr. Darlington will divide his time between the two cities.

THE DICKINSON ELECTRIC SUPPLY COMPANY will remove May 1, from 150 Nassau street to 141 Broadway. This is the company handling the "Alpha" sign lamp, and their new location gives them better office accommodations, more commodious quarters and better shipping facilities than at present afforded them.

MESSRS. LEVY & MEYERS have recently been appointed agents for the well-known Starbuck & Davidson exhaust fans, and are doing business under the name of The Cable Electric Construction Company, No. 621 Broadway. They are prepared to furnish estimates on all kinds of electrical work and to supply and install the above-named fans.

THE AMERICAN ELECTRICIAN COMPANY, of New York City, has been formed to edit and publish magazines, newspapers and books and deal in electrical appliances. Capital, $50,000, and directors: Emmet L. Powers, of Chicago, Ill.; W. D. Weaver, of New York; Elmer E. Wood, of Brooklyn; Edward Caldwell, of Plainfield, N. J. ,and C. E. Whittlesley, of Madison, N. J.

MR. EDWARD F. WHITE has recently opened offices at 136 Liberty street, New York, and is conducting a general mechanical engineering business, giving special attention to the designing and operation of manufacturing works. Mr. White also makes a specialty of introducing labor-saving machinery for handling various materials and products of manufactories, and recommends special arrangements for increasing the economy of operation of steam plants and other machinery.

cialty for this season. It is made both single and three-returned from South Africa full of interesting reminiscences of travel. He is a shrewd and close observer, and as he was in Pretoria when the "Raiders" were in jail, he speaks on recent events with the authority of an eye-witness. Mr. Shippy is a "liberty man" if ever there was one, but he is decidedly not an advocate of the Boers, to whom a self-governing American is just as obnoxious as a gold-seeking Englishman.

THE UNITED STATES PROJECTILE COMPANY, of Brooklyn, N. Y., are erecting a new building to meet the large demand for their products. The new building will be 100 feet wide and 450 feet long, of steel skeleton structure throughout. The steel work for the building has been designed and will be erected by the Berlin Iron Bridge Company, of East Berlin, Conn. The trusses have a clear span of 100 feet, and the general construction is such that it will make one of the finest buildings of the kind in the country.

THE SOUTH AMERICAN LIGHT, POWER AND TRACTION COMPANY, of Lima, Peru, has just placed a contract with the General Electric Company, of New York, for the installation of a 5,000 h. p. electrical plant. The dynamos will be erected at the waterfalls eleven miles from Lima, and the electric power generated will be transmitted to the city, where it will be used to operate the surface railways and electric lights and furnish to the public generally such electric power as may be required. This will be the largest installation of electricity in South America.

Department News Items will be found in advertising pages.

THE
Electrical Engineer.

Vol. XXI. MAY 27, 1896. No. 421.

ELECTRIC LIGHTING.

THE RECONSTRUCTION OF THE PLANT OF THE CHICAGO BOARD OF TRADE.[1]

BY BION J. ARNOLD.

THE plant involves a number of departures from the standard lines of office building engineering, and if the results of the operation are as successful as it now seems, after running a short period, the annual expenses of the operation of the plant will be reduced from $25,000 to $15,000, and consequently the results obtained from its operation will be watched closely by the members of the Board of Trade who have the matter immediately in charge.

The writer believes that all the energy required to produce motion and light in an office building should be developed in one set of steam engine cylinders and on one generator. This set of cylinders, together with the working parts of the engine and its generator connected directly to it, constitute the unit which produces the energy of the plant, and this unit should be made to work at its maximum economical load throughout its entire period of operation, while the energy from the unit should all be utilized during its running time. Having this idea constantly in view, the designer of this plant has planned to follow it out as closely as possible.

It became apparent after an examination of the old plant that if the steam pressure could be increased to 125 pounds per square inch, instead of 75, so as the get the advantage of drier steam, and all the pumps in the plant which were consuming steam full stroke eliminated, and the energy of the plant produced by a compound condensing engine running at an economical load, a large reduction in the operating expenses of the plant could be effected. The adoption of a compound condensing engine to work under this increased steam pressure was a natural sequence which enabled the energy to be produced with the least possible coal consumption. After quite an extended investigation it was decided to supplant the hydraulic elevators with horizontal screw multiple sheave elevators, as the investigation showed that these machines could be operated for considerably less money per car mile than the hydraulic machines, under the conditions which existed in this plant. The operation of these elevators in practice has fully proven the correctness of this position. They have been in operation about four months now, on an average consumption of 4¼ kilowatt-hours per car mile.

The general plan of the plant is as follows:

The installation consists of the following: Five 66 x 16 feet horizontal tubular boilers, designed to carry 125 pounds pressure per square inch; two 150 horse-power horizontal compound condensing engines running at 275 revolutions per minute, each directly connected to a 75 kilowatt direct current generator, under a special system devised by the writer, which permits of either or both generators being driven from either engine. Four horizontal 30 horse-power multiple sheave elevators; six 10 horse-power electric motors, five of which operate ventilating fans, and one the machinery in the machine shop. There are also sixty-five 1,600 ampere-hour storage cells, and the necessary switchboard and connections for the handling of the above machinery. One of the compound steam pumps has been retained in order to keep the tank on the roof of the building supplied with water for use in the wash-basins, closets, etc. It may prove advantageous in the future to substitute for this an electrically driven pump, but it has been thought best not to discard the old one at present, inasmuch as it is already on hand.

The losses in wiring circuits of the building are computed as follows: Between generator and switchboard, one-half of one per cent.; between switchboard and center of distribution two and a half per cent.; from center of distribution to secondary mains, one per cent.; between secondary mains and lights, one per cent.—making the total loss between generator terminals and lights five per cent.

Fig. 2 represents largely diagrammatically the switchboard of the plant. From this it will be noticed that the plant is designed for three generators, but two of which are now in operation, as they are sufficient for the work. In the main lighting bus-bar is placed the recording wattmeter, which registers all the energy delivered from the generator to the light and motor portions of the plant. In the elevator bus-bars is placed another recording wattmeter, which registers all the energy delivered to the elevators from the lighting bus-bars. With this arrangement and the means available in the plant for measuring the amount of coal and water consumed, the operators are enabled to keep accurate daily records of the cost per kilowatt of the energy produced and delivered by the plant.

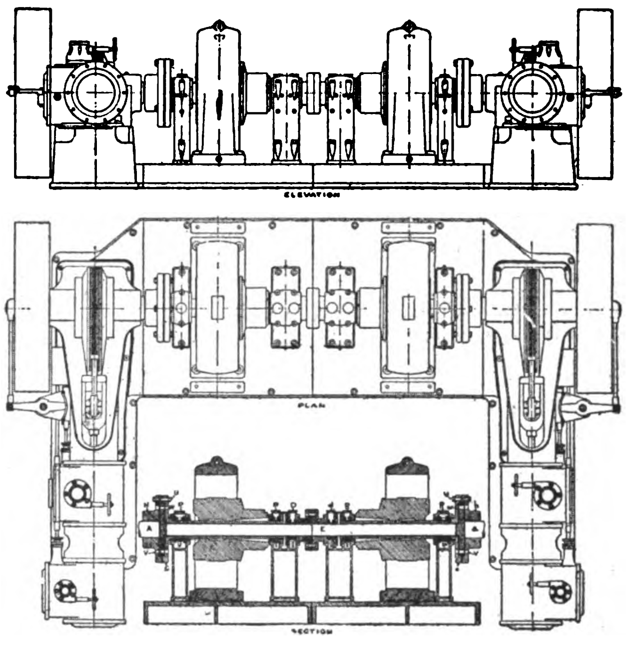


FIG. 1.—THE ARNOLD METHOD OF ENGINE AND DYNAMO CONNECTION, BOARD OF TRADE PLANT, CHICAGO.

The generators are connected to the board by means of two switches, one of which is a triple-pole double-throw switch, and is arranged so that when thrown into the upper position it connects the generator to the elevator bus-bar, using the compound winding of the generators. This arrangement permits the generator to operate the elevators and take care of the variable load without the use of the batteries. When the same switch is thrown in its lower portion, the circuits are so arranged that the compound or series winding of the generator is cut out, and the equalizer connection from the generator becomes the positive connection, and the generator is connected to the elevator bus-bars shunt wound, thus eliminating its series winding. With this arrangement, the generators and the batteries are run in multiple on the elevator load.

Referring now to the right hand part of the board, which is the storage battery proper, the operation is as follows: Under normal conditions, any elevator is operated shunt wound in parallel with the batteries by closing its corresponding switch downward. In this position whatever number of batteries are

[1]Read before the American Institute of Electrical Engineers, New York, May 20, 1896. Abstract.

being operated in this series, are in parallel with the generator. The hand regulator is placed in the position indicated to enable the operator to cut in a sufficient number of cells in parallel with the generator, so that the cells will be constantly charging during the time of operation of the elevators, except at the temporary moments of overload caused by an excessive

winding used when the batteries are being run in parallel with the elevators and lights. When the demand for current from the cells is great, as, for instance, when the elevator load is severe, the electromotive force of the number of cells in parallel with the elevators necessarily drops, consequently the electromotive force of the number of cells in parallel with

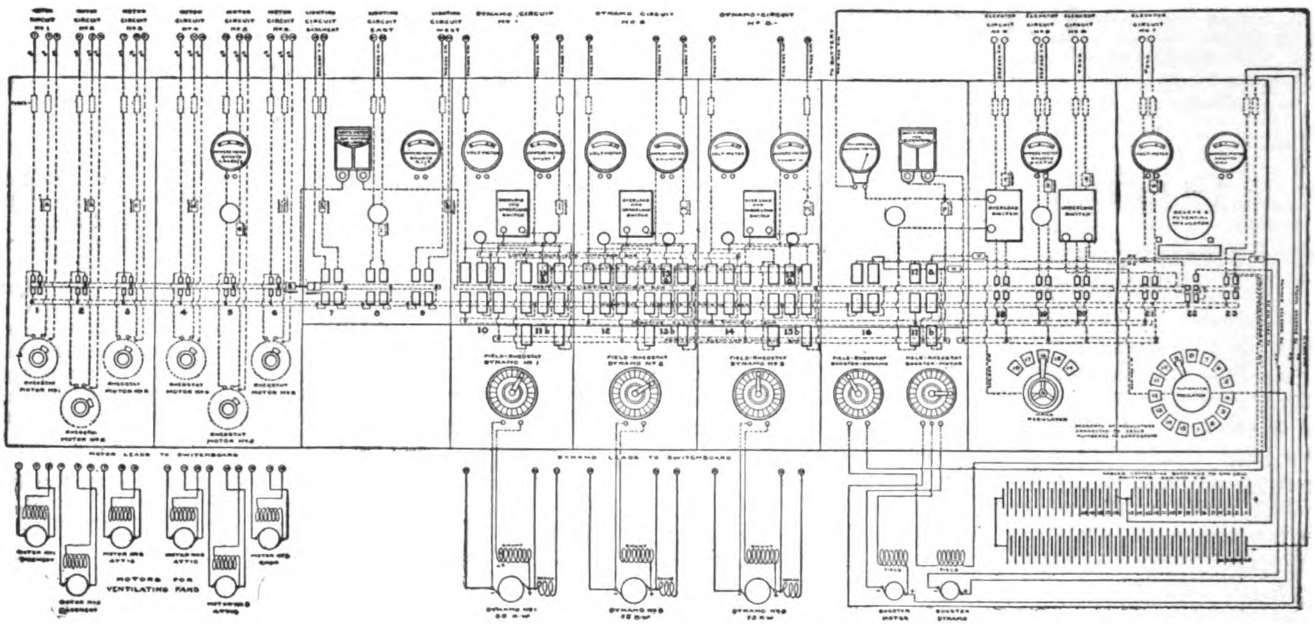


FIG. 2.

demand for current by the elevators. When this pull from the elevator occurs, the batteries respond and take the surplus load from the generator. With this arrangement, about fifty of the cells will be kept constantly charged, and in parallel with the elevators. In case the amount of current entering the cells is excessive between the intervals of heavy load on the elevators, the hand regulator is adjusted so as to cut in one or more cells until the current becomes reduced to the proper amount for the batteries; and, on the other hand, if the amount entering the cells is not enough to keep them properly charged, the hand regulator is adjusted so as to cut out a number of cells until the proper amount of current is reached.

In order to operate the batteries in parallel with both the

the lighting bars, which includes all the cells working with the elevators, and a few of the regulating cells, would correspondingly drop, and some means must be provided to hold up the voltage of the lighting bus-bars. This is accomplished by means of the automatic regulator, which is controlled by a solenoid switch, shown in the upper right hand portion of the diagram.

To charge all the cells in series from one of the main generators, it is necessary to increase the electromotive force a sufficient amount to overcome the total voltage of the cells. This is done by placing the generator portion of the booster or motor-generator in series with the main generator.

The method of connecting the engines and generators is

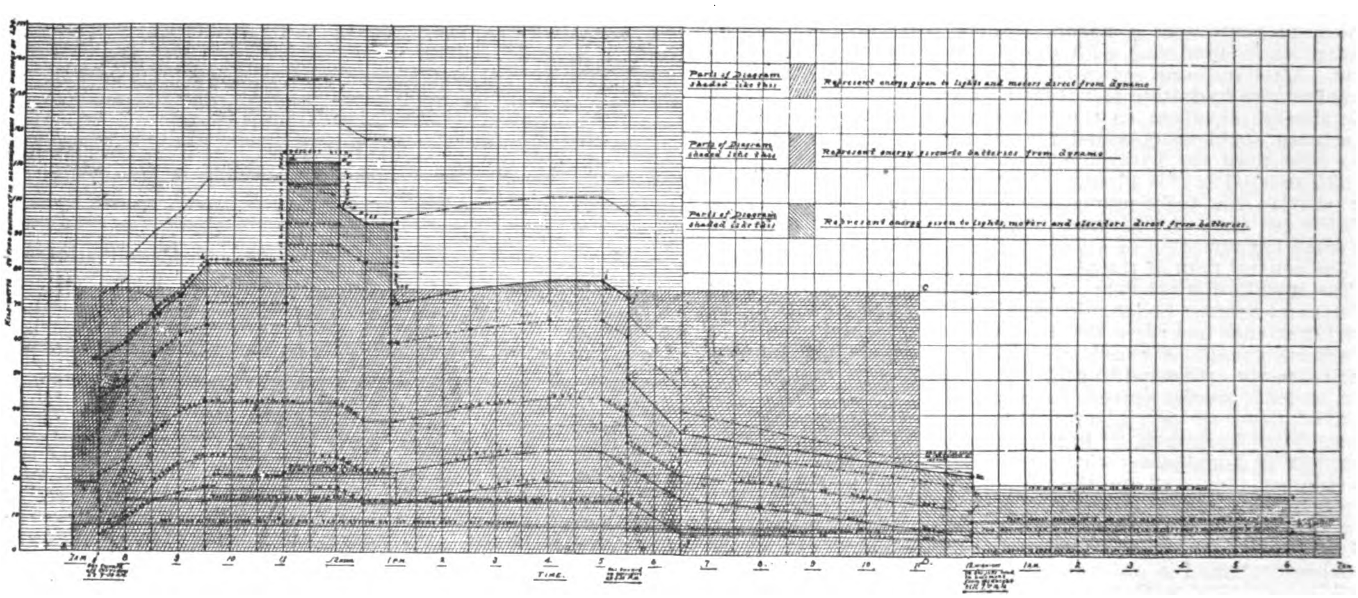


FIG. 3.—DIAGRAM SHOWING DISTRIBUTION OF LOAD BETWEEN DYNAMO AND STORAGE BATTERY IN CHICAGO BOARD OF TRADE PLANT.

lighting and the elevator bus-bars at the same time and maintain a practically constant voltage on the lighting bus-bars, it is necessary to operate the generators shunt-wound instead of compound-wound. As before shown, the switches are so arranged that the compound winding of the generators can be utilized when the batteries are not in service, and the shunt

shown in Fig. 1, and represents a system planned by the writer, which enables a direct coupled plant to be so built as to have the advantage of an independent unit when operating under normal conditions, and all the advantages of a belted plant in case of accident to any particular part of the plant. The cut shows the plan, elevation and section. Referring to

the sectional view, A a represents the ends of the engine shafts, which carry discs, H h. The generators are mounted upon hollow sleeves or quills, which are supported in independent bearings, P P and p p. The ends of these quills are enlarged to form flanges corresponding in diameter and thickness to the engine flanges. Between the shafts of engine, A a, extends an auxiliary shaft, E, (coupled at its center, in this case, to permit half of the plant being put in operation before the other half is ready), and carried in independent bearings, D d. This shaft, E, carries at each end circular discs, which in this case are forged solid with the shaft. Under normal conditions shaft E does not revolve, but lies passive in bearings, D d, and the engines drive the generators direct coupled, by inserting the bolts, U u, three of which, spaced 120 degrees apart, are used in each coupling. It is now evident that each engine is operating an independent direct coupled generator without revolving any more shafting or machinery than is usual in ordinary independent direct coupled plants, inasmuch as the quills which surround the auxiliary shaft, E, do not come in contact with it, but have a clearance of one-quarter of an inch all around it. By a very simple manipulation the right hand generator can be driven from the left hand engine, or both generators from either one of the engines. By using compound engines, so designed that by working high pressure steam in the low pressure cylinder, one engine can be made to double its power for a few hours. The plant has thus the total generator capacity available at all times and allows one engine to be in reserve for repairs, thus doing away with the investment of the third unit, which is usually carried in such plants for safety. The system, when used without the battery auxiliary instead of being provided with bolted connections as here shown, is provided with magnetic clutches, which permit the generators to be brought up to speed as motors, and thrown in connection with the engines without stopping either engine. This makes it possible to connect either generator with either engine without shutting down the plant in any part. With such an arrangement, with the engine and generators equal to the maximum capacity of the plant, and battery auxiliary equal to one-third the capacity of the plant, any office building can be operated in the most economical manner, according to the writer's belief.

The engines are operated during the summer compound condensing, by using a cooling pan system and siphon condenser. With this arrangement the condensing water is cooled by means of the 72-inch ventilating fan, which is in operation during the entire sixteen-hour run of the plant, and is used for ventilating the building. It was thought advisable to utilize the air from this fan for cooling the water, inasmuch as the energy for driving the fan had to be produced, and utilizing the air from the fan would not entail any additional expenditure of energy upon the plant over that required under ordinary conditions.

Fig. 3 represents the load diagram of this plant. The parallelogram, A, B, C, D, representing the total capacity in kilowatt hours of one of the generator units, assuming that the unit starts at 7 o'clock a. m. and operates until 11 o'clock p. m. The line, a, b, c, d, e, f, g, h, i, j, k, l, m, represents the load line, or energy required by the building during the same period. That portion of the diagram shaded with lines inclining to the right at an angle of 45 degrees represents the amount of energy passing into the batteries, while the portion of the diagram represented by shade lines inclining to the left at an angle of 45 degrees represents the amount of energy delivered from the batteries. It will be noticed that from 11 p. m. until 7 a. m. the entire load of the plant is operated by the batteries alone. With this arrangement but two shifts of labor are required, one operating from 7 a. m. until 3 p. m., and the other from 3 p. m. until 11 p. m. From 11 p. m. until morning during the winter the watchman acts as fireman for the boilers to maintain the steam heat in the building.

STANDARDS OF LIGHT.[1]

BY EDWARD L. NICHOLS, CLAYTON H. SHARP, AND CHARLES P. MATTHEWS.

THE sub-committee appointed to investigate the subject of a suitable standard of light for photometric purposes has been engaged upon preliminary experiments, and upon the collection of data concerning existing standards, and also such other sources of light as may be regarded as possible substitutes for the present standards. The committee is still at work upon these preliminary experiments, but it has reached a stage when it seems desirable to make some report of progress.

The following sources of light have been in use in photometric work for a sufficient length of time to enable various observers to become acquainted with their merits and likewise with their imperfections. (1) the Carcel lamp, (2) the British standard candle, (3) the German standard candle (Vereinskerze), (4) the Methven screen, (5) the Hefner-Alteneck amylacetate lamp, (6) the Harcourt pentane standard, and (7) the Harcourt pentane lamp. In addition to these there have been suggested the Violle platinum standard, various luminous gas flames, the crater of the positive carbon in the arc, and the surface of a strip of platinum heated by means of a current to an arbitrarily defined temperature. In the case of many of these sources of light the members of the committee have made extensive measurements of their own, both to verify existing statements and to investigate questions yet unsettled.

The report of the sub-committee describes and illustrates at considerable length the bolometer—an instrument for detecting fluctuations of light—which was used in testing the standards of light named above, as well as several others, and gives a large number of curves and tables showing the results of numerous experiments. The conclusions drawn from these data by the committee are as follows:

It is evident from the summary of previous photometric researches and from the report of the work of this committee, that of all standards thus far used, candles are the least reliable. It is also evident from the bolometric curves that naked flames are subject to sudden and rapidly recurring fluctuations that may be almost entirely eliminated by the use of a properly constructed chimney.

It seems likely that many of the difficulties which are unavoidable with flame standards may be overcome by the adoption of a standard consisting of some surface electrically heated to a standard temperature.

The definition of the degree of incandescence of such a surface appears at the present to present almost insuperable difficulties, but the committee is at work upon a method for the measurement of the temperature of incandescent carbon, which may lead to results looking towards a solution of the problem.

It also has in progress experiments looking to the production of a light standard in which not only the burning material but also the atmosphere shall be of known and definite chemical composition. Liebenthal's experiments indicate clearly that this is a necessary condition to the production of any invariable flame. In the preliminary experiments now under way, a flame of a mixture of two parts acetylene to one part hydrogen, burns in a current of pure oxygen, all the gases being dry. The flame produced by these means is of dazzling brilliancy, its color being comparable to that of the lime light. No accurate measurements of its steadiness or reproducibility have yet been made.

This experiment will include a spectro-photometric study as well as an investigation of the range of fluctuation to which it is subject under different conditions of combustion.

[1]Preliminary report of the Sub-Committee of the American Institute of Electrical Engineers. Presented May 20, 1896.—Abstract.

AN ANALYSIS OF TRANSFORMER CURVES.[1]

BY CHARLES J. HUGUET.

THIS paper describes a number of experiments in regard to the distortion of primary current curves on open secondary. This was one of the most noteworthy features of Professor Ryan's paper on "Transformers," read before the Institute, and Professr Ryan ascribed this distortion to hysteresis. The same opinion seems to have been held by Fleming, Steinmetz, and every other writer since that time, with the single exception of Professor Rowland.

Dr. Sumpner had previously shown that, assuming hysteresis absent, a variation in the value of the permeability will superpose on the sinoidal magnetizing current a system of higher harmonics, causing it to become a symmetrically peaked curve. Professor Rowland, however, went further, and declared that the presence of the distorting harmonics is due, not to hysteresis, but to change in permeability, the effect of hysteresis being capable of representation as a simple resistance. However, he simply expressed this theory mathematically, without giving any experimental verification, and it is doubtless for this reason that the results of this paper have not been accepted in their entirety. This apparent conflict of opinion seemed to warrant further investigation, and it was the object of experiments conducted by the writer at Tulane University in June, 1895, to throw light on this question by analyzing the current curve into its various components.

The method employed in the measurement of the instanta-

[1]Read before the American Institute of Electrical Engineers, New York, May 20, 1896.—Abstract.

neous values was essentially similar to the telephone method described by Professor Nichols in his "Laboratory Manual," a galvanometer being substituted for the telephone. Runs were made at different voltages and rates of alternations from which the data were sufficient to discriminate the eddy from the hysteresis losses. By dividing the watts lost by eddies by the electromotive force applied the effective current due to eddies is obtained, and the ratio of this to the aforesaid electromotive force is the conductance due to eddies.

If the instantaneous values of electromotive force be multiplied by this conductance, and the resulting eddy current curve be subtracted from the original current curve the remainder will be the hysteresis curve; i. e., the curve that would be derived from the hysteresis loop. If in the same way we determine the conductance due to both eddies and hysteresis; i. e., if we represent the hysteretic loss as one due to a simple constant resistance, and subtract the effective current curve thus determined from the original current, the remainder will be a true wattless current, since the curve subtracted itself accounts for the watts lost. The wattless remainder is very fairly symmetrical with respect to the flux curve and is of the peaked character to be expected with permeability variable and hysteresis absent. A similar treatment of Professor Ryan's curve yielded a wattless remainder of similar character. These results seemed to verify Professor Rowland's theory, at least approximately.

But equally strong proof is afforded by several curves in the paper of Steinmetz—"On the Laws of Hysteresis" (Part III.).

The writer concludes that for sinoidal electromotive force:

(1) Hysteresis may in all respects be replaced by a constant resistance if the hysteretic characteristic be the quadrant of an ellipse.

(2) This condition is approximately satisfied for moderate ranges of magnetization (such as are used in practice), in reasonably good iron, and the higher harmonics are negligible. There will usually be a particular range that will give a nearly perfect approximation. On contraction of the range, the hysteretic current becomes more pointed than the sine, and on expansion beyond the critical range more flattened than the sine.

(3) The increased distortion of the hysteretic current for higher ranges will cause an increase in the higher harmonics, but the rapid diminution in the permeability on approaching saturation will cause a much greater increase in these harmonics, so that even at higher ranges the distorting influence of hysteresis is comparatively slight.

As a final conclusion, then, we may say that Professor Rowland's hypothesis that the higher harmonics in the transformer for sinoidal electromotive forces are due, not to hysteresis, but to variation in permeability, and that the effect of hysteresis may be represented by a constant resistance, is approximately correct, for reasonably good iron, is very nearly correct for the moderate ranges used in practice, and may, under certain conditions, be absolutely correct.

PARALLELING ALTERNATING STATIONS FOUR MILES APART.

A NOVEL method of central station working with alternating current apparatus has recently been installed by Mr. N. T. Wilcox, for the Seneca Light and Power Company, of Seneca Falls, N. Y. The installation is especially interesting, as it is the first instance where two alternating current machines, located in stations widely distant from one another, have been operated in multiple under the conditions incident to everyday central station practice.

Two 100 kilowatt, composite wound, 60 cycle, 2,300 volt General Electric generators have been installed, one being located about four miles from Seneca Falls, in the Waterloo station, which is operated by water-power only. Lights and power are furnished for general distribution at both ends of the line. The second generator is located in the Seneca Falls plant, where there is both steam and water-power. These two machines replace an Edison three-wire system in Waterloo, a 500 volt direct current motor system, and 1,000 volt single-phase alternating current system in Seneca Falls.

The incandescent lighting for both towns has been ordinarily operated from the Waterloo generator, the Seneca Falls dynamo being used only in emergencies or at such times as it was desirable to shut down the Waterloo plant. There being a large surplus of power at Waterloo the greater portion of the night, it is desirable to use this surplus for street lighting, but in case of low water it is necessary to have the arc dynamos in Seneca Falls, where there is steam power for emergencies of this kind. Consequently it is desirable to transmit this surplus water-power to be used on the main shaft of the Seneca Falls plant.

This problem is admirably solved by synchronizing the generators and throwing them in multiple, working both lights and power over the three No. 6 B. & S. wires which connect the Seneca Falls and Waterloo plants, nearly four miles apart. The Waterloo wheels are then run at full gate, transmitting their full power to the generator.

The regulating is done at the Seneca Falls end of the line. The surplus power not required for incandescent lights supplies energy to operate the Seneca Falls machine as a synchronous motor, the latter transmitting the power to the line shaft. As the lighting load falls off, the energy so saved is utilized in driving the shaft, until the amount delivered to the shaft entirely relieves the engine of its load, after which the steam power is cut off. By carrying a strong field on the Seneca Falls machine, all drop of potential due to line induction is entirely eliminated.

The working of the system has been most satisfactory, and especially so as the load is nearly all a lighting service, and the potential at both ends of the line is under perfect control. The increased economy of operation of the plants is quite noticeable, as it is now possible to utilize the maximum water-power during the whole evening.

EFFECT OF TEMPERATURE ON INSULATING MATERIALS.[1]

BY GEO. F. SEVER, A. MONELL, AND C. L. PERRY.

OF the many kinds of insulation, a few of the most common were chosen, i. e., paper, cloth, oiled paper and oiled cloth, and the following conclusions have been drawn from the result of 102 tests on samples of materials, which were kindly furnished by several of the most prominent manufacturers of electrical machinery.

The Apparatus.—The heating apparatus consisted of a glass cylinder 8 inches in diameter and 10 inches high, covered at the top and bottom with asbestos plates. The lower part of this cylinder was occupied by twelve enamel resistance tubes, 5 inches long and 24 ohms each. The terminals of these were

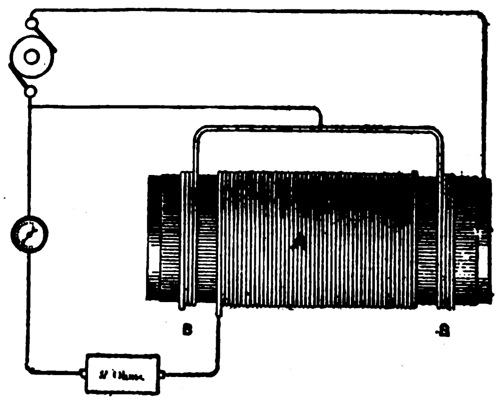


Fig. 1.

brought out through the asbestos plate. The current in these tubes being controlled by rheostat, the temperature in the cylinder could be varied at pleasure. An inch above the heating tubes, and supported by an asbestos collar, was a metal plate having holes punched in it to allow the free circulation of air in the cylinder. This plate was connected to one side of a galvanometer.

The insulating material to be tested was wrapped on brass cylinders ¾ inch in diameter and 3 inches long, the insulation not reaching quite to the end of the tube. The insulation was then wound with No. 26 B. & S. bare copper wire for a space of 2½ inches.

A Thomson high resistance galvanometer, a megohm box and a difference of potential of 500 volts were used in the tests. The thermometer used was of the nitrogen-filled mercurial type and capable of measuring from 0° to 400° C. When troubled with surface leakage, it was eliminated in the following simple manner. The diagram shows the connections while testing a tube and also the leakage shunt.

It will be seen from the diagram, Fig. 1, that all of the current going through the galvanometer must pass from the dynamo to the brass cylinder, and thence through the insulation to coil and on through the galvanometer. Any current tend-

[1] Read before the A. I. E. E., May 20, 1896.—Abstract.

ing to leak over the surface of the insulation from the brass cylinder to coil will be intercepted and shunted past the galvanometer by coils B B.

Plain Paper.—In this class forty specimens were tested. After the resistance at the temperature of the air (22° C.) was carefully noted, the temperature was gradually increased (100° in one-half hour) and readings taken every 10° up to 80° and from there on every 20°. Fig. 2 shows a curve which is characteristic of practically all kinds of plain paper.

It should be noticed, however, that in general the resistance

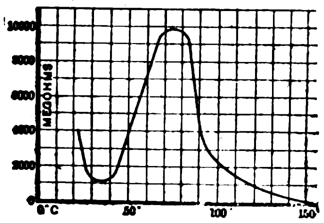


FIG. 2.—PLAIN RED PAPER, .009 IN. THICK.

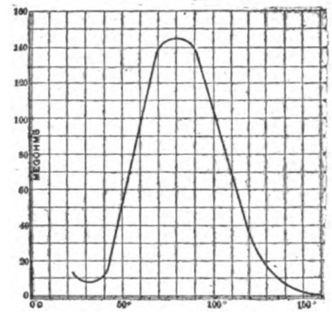


FIG. 4.—PLAIN COTTON DUCK, .015 IN. THICK.

of papers that are not protected from moisture falls between 22° and 50° and then rises rapidly until at 75° it has attained a maximum resistance. It should also be noted that this temperature of 75° is very constant for all kinds of paper. From 75° upward the resistance falls rapidly and at 150° is but a small fraction of its initial resistance.

The initial resistance of paper protected from moisture by japan (Fig. 3) is very high, but falls rapidly with the increase of temperature, as is the case with all material protected from moisture. (See oiled paper and oiled cloth.) Hence we see that all paper having a porous structure and therefore containing more moisture, has a lower initial resistance than the protected paper, but is affected by heat much less than the latter. This would lead to the conclusion that there are two phenomena taking place. First, the driving off of the moisture, which tends to increase the resistance, and secondly, some change (not a mechanical deterioration), in the material, dependent on the temperature and which may be called the temperature co-efficient. This temperature co-efficient tends to lower the resistance with increase of temperature.

Examining the several curves shown, we see that the initial resistance of unprotected papers is low on account of the presence of moisture. Now, on gradually increasing the temperature, the resistance falls during the first 20° or 30°, because the effect of the temperature co-efficient predominates during this period and before the material is warm enough to start the evaporation of the moistrue it contains. This, however, lasts but a short time, as the result of the evaporation is to increase the resistance very rapidly, until at 75° the temperature co-efficient again asserts itself and the resistance rapidly falls.

In the case of japanned papers (Fig. 3) the initial resistance is very high, due to the absence of moisture, but on being heated the resistance drops rapidly as the small quantity of water contained is evaporated off so slowly that it has very little counteracting effect on the temperature co-efficient.

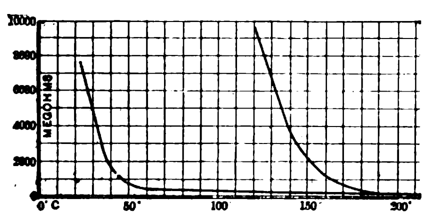


FIG. 3.—JAPANNED RED PAPER, .01 IN. THICK.

Paper does not seem to deteriorate mechanically at less than 180°; above this point the material begins to carbonize. At 230° a peculiar phenomenon takes place. The material after possessing a very low resistance from 175° upward, would at about 230° suddenly increase greatly in resistance and immediately after break down. This may be caused by some molecular rearrangement taking place at that temperature which changes the resistance of the material. Other cases wherein the resistance of a body changes at a certain temperature are well known, such as the recalescence of iron.

It would seem that paper insulation has a critical temperature somewhat analogous to that of iron, steel and nickel, but, of course, the characteristics of the materials are too different for any close similarity.

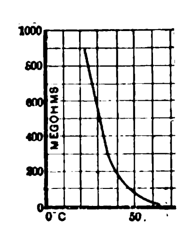
Plain Cloth.—Under this head twenty specimens were tested, including canvas, linen and muslin, of different thicknesses. The action of this material (Fig. 4) is much the same as that of paper (Fig. 2). The initial resistance is lower, as it contains more moisture than is the case with paper; for the same reason when the moisture evaporates off, the increase over the initial resistance is greater than with paper. By reference to the curves of paper and cloth it will be noticed that their resistance varies in the same manner. For cloth, as for paper, the maximum resistance is at 75° C. The material does not begin to carbonize until at a temperature of 180° C., and even beyond that point it loses its mechanical strength very slowly until past 220°. The explanation for the resistance of cloth varying as it does is exactly similar to that for paper.

Oiled Paper.—In this class fourteen tests were made, on papers of different thicknesses. With the single exception of one specimen (the resistance of which was very high) the initial resistance was lower than in the case of paper. (Compare Figs. 2 and 5.)

On increasing the temperature the resistance fell rapidly, the curve being much the same as that for japanned paper. The reason for the sudden decrease in resistance is the same as that for japanned paper. Oiled paper deteriorates mechanically at a lower temperature than paper or cloth, commencing to blacken at so low a temperature as 120° C.

Oiled Cloth.—In this class twenty-eight specimens of oiled silk, muslin, and linen of various thicknesses were tested. The initial resistance of this material is much lower than that of paper, and on increasing the temperature the resistance falls rapidly, the shape of the curve (Fig. 6) corresponding to those of japanned and oiled paper. The reason for the sudden decrease in resistance is undoubtedly the same as for the japanned and oiled paper. The insulation begins to char at about 120° C.

General Conclusions.—In the foregoing discussion there are



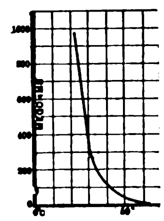


FIG. 5.—OILED PAPER, .0045 IN. THICK.
FIG. 6.—OILED SILK, .007 IN. THICK.

some main points to which it is necessary to draw attention. These are:

(a) That paper is a better insulation and withstands increase in temperature much better than cloth (shellac and varnish were not used in any of the experiments), oiled paper or oiled cloth.

(b) That paper and cloth have a maximum resistance when first heated at about 75° C. and are not injured mechanically under 180° C.

(c) That the point of maximum resistance for paper and cloth (in this case 75° C.) depends on the rapidity with which the temperature is increased. The authors suggest that if the material were kept at a constant temperature until all the moisture had been evaporated, the resistance of the material would then be its true resistance at that temperature.

(d) That all give a high resistance after cooling, but have little mechanical strength.

Oiled paper and oiled cloth, however, after having been heated to 220° C. and allowed to cool, not only have a high resistance, but became so firmly fixed to the brass cylinders that it was found necessary to remove them with a file.

(e) That it would be well to bake paper and cloth insulation to 140° C. before applying varnish or shellac.

(f) Referring to Fig. 3, it will be seen that on decreasing the temperature the resistance increased, but the second curve does not by any means coincide with the first. On further experimenting in this direction, it was found that there is no temperature at which the curve with falling temperature coincides with the first. This may be due to more moisture being driven out at higher temperatures which is not absorbed by cooling.

Here it may be well to mention an interesting phenomenon

that occurred in connection with this investigation. When the temperature has risen above 100° C., the zinc in the brass cylinder begins to leave its surface and combine with the copper wire wrapped about the insulation, so that the wire has a brass surface and the brass cylinder a copper surface.

VACUUM TUBE LIGHTING BEFORE THE A. I. E. E.—TEST OF MOORE VACUUM TUBES.

THE principal topic of discussion at the meeting of the American Institute of Electrical Engineers last week was the paper on "Vacuum Tube Lighting," read by Mr. D. McFarlan Moore, at the previous monthly meeting of the Institute.

Full scope was given to the members, and as a result elaborate discussion ensued, in which Mr. Steinmetz, Dr. Nichols, Professor Anthony, Mr. Hering, Mr. Kennelly, and a number of others participated.

The views expressed seemed to differ considerably, but there seemed to be a general consensus of opinion that a statement of the power consumed in Mr. Moore's tubes was what was wanted at this time. This information was supplied by Mr. Joseph Wetzler, who gave the following results of a series of tests made by him on May 18 in the booth of Mr. Moore at the exposition. These tests were taken by placing a Weston direct current milliammeter in the circuit of the Moore inductance coil, and reading the potential across the main leads to which the inductance coil was connected by means of a Weston alternating and direct current voltmeter.

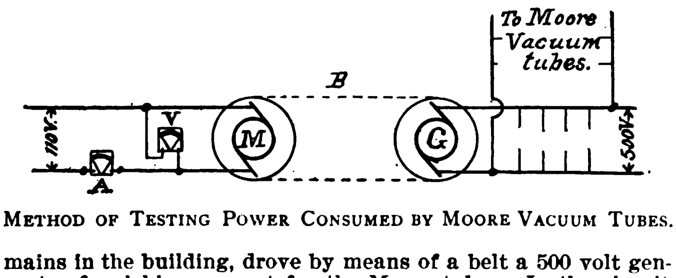
	Volts.	Milli-amperes.	Watts.
Tube No. 1, good tube	490	110	53.9
	470	110	51.7
Tube No. 2, poor tube, faint light	480	160	76.8
	480	160	76.8
Tube No. 3, good tube	500	85	42.5
	485	110	53.3
	485	110	53.3
	485	110	53.3
	490	110	53.9
	490	110	53.9
Tube No. 4, good tube	490	108	52.9
	485	108	52.4
	470	108	50.7
	490	110	53.9
	470	105	49.3
Tube No. 5, good tube	500	*88	44.0
	500	*88	44.0

* With momentary rise to 120.

Professor Anthony, as well as others, expressed doubts as to the accuracy of the results obtained, owing to the peculiar nature of the current measured and suggested that a more reliable method would be to measure the energy consumed not by the generator supplying the current for the Moore vacuum lamps, but to measure the energy consumed by the motor which drives the Moore generator at the exposition.

In the evening the suggestion made by Professor Anthony was carried out in a test made by Prof. Anthony, Dr. E. L. Nichols, Mr. N. W. Perry, and Mr. W. W. Ker, on the tubes in the Moore exhibit.

The arrangement adopted is illustrated in the accompanying diagram. The motor, M, taking current at 110 volts from the



METHOD OF TESTING POWER CONSUMED BY MOORE VACUUM TUBES.

mains in the building, drove by means of a belt a 500 volt generator furnishing current for the Moore tubes. In the circuit of the motor was placed the ammeter, A, and across the terminals of the leads the voltmeter, V. The report of these tests as made to Mr. Moore by Professor W. A. Anthony is as follows:

"A Weston ammeter was placed in the circuit leading to the motor used for driving the generator which furnished the current for the vacuum tubes, and a Weston voltmeter was placed across the motor terminals. These instruments were read at frequent intervals, while one of us in the booth below noted the time of turning on and off the light. Comparing notes we found that when the tubes were all off, the motor consumed 12.5 to 13 amperes at 110 volts as a constant load. When the tubes were all on, the motor consumed 22 amperes at 108.5 volts. The motor therefore consumed, when tubes were not running, 1,402 watts; when the tubes were all running, 2,837 watts; due to tubes, 985 watts.

"There were in operation fourteen tubes, 7½ feet long, 1¾ inches diameter, one tube somewhat shorter, but 2½ inches in diameter, and a few tubes of special designs.

"We estimated that the whole was an equivalent of sixteen of the 1¾-inch tubes. This gives 61.6 watts per tube applied to the motor terminals. Assuming that 80 per cent. of this energy was delivered to the tubes from the generator terminals, the power consumed by each tube is 49.28 watts.

"This is practically the result obtained by Mr. Wetzler, by direct measurement of the energy consumed by the tubes, and disposes of the question raised by the writer as to the reliance to be placed upon the indications of a Weston ammeter in circuit with a vibrating interrupter.

"The only question now is as to the intensity of the light obtained. Of this it was impossible, under the conditions, to make any reliable estimate. Our results simply show that the light of the vacuum tubes as exhibited in your booth at the exposition is obtained at the expense of a little more than one horse-power.

"The instruments used in making these measurements were kindly loaned for the purpose by Mr. Pionnie, in charge of the Weston Electrical Instrument Company's exhibit, who gave us his assistance in making the necessary connections and in taking readings."

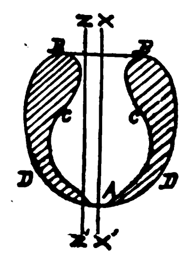
SUGGESTIONS FOR X-RAY EXPERIMENTS.

BY PAUL A. N. WINAND.

NOTWITHSTANDING the fact that a great number of investigators have lately operated with X-rays, it seems that one experiment has thus far been overlooked.

The most puzzling feature about these X-rays is that their course cannot be deviated from straight lines. In consequence, reasonings similar to those which enabled one to draw conclusions as to the nature of ordinary light, from the now classical experiments, cannot be as yet attempted for the X-rays. It has been found that X-rays will produce the discharge of a charged surface on which they impinge, and it would seem natural that this action should be attended by a reaction of the charged surface upon the X-rays. It would be interesting to investigate and determine whether such a reaction takes place or not, and if it does, it would afford a starting point for drawing conclusions as to the nature of the rays.

The charged surface may cause either a deflection or a



A SUGGESTED X-RAY EXPERIMENT.

reflection on the rays, or both; it may do so even without changing their course by polarization or by changing the phase, and this would be detected by interferences.

The first thing to try might be to interpose a hollow sphere, charged to a high potential, in the path of the X-rays. A thin rubber ball, aluminum plated, would absorb very little of the rays when not charged. If a deflection occurs, hollow prisms with rounded edges could be used. Two parallel surfaces would probably act like a plate of glass on light when the two surfaces were charged at the same potential—different from that of the surroundings—but they would act in quite another manner when the surfaces are charged oppositely, forming a condenser.

In order to submit the rays to the action of a single surface one might use a body shaped as is shown in the figure. A is a very small aperture; B, a much larger one. The body might be formed by the rotation of the loop A D B C about X X' as an axis, and the outer surface, A D B might be highly charged, while the inner surface would have but a slight electric tension. The ray, Z Z', would therefore pass through only one

highly charged surface, while the ray, X X', would not traverse any such surface.

A highly charged insulating substance would probably show an increased absorption, or a dispersion of the rays, even if the effect with one or two surfaces is not sufficiently marked to be detected. It would also be interesting to know if, and in what manner, the rays would be influenced when they are passed through a conductor traversed by a strong electric current. A conductor of aluminum will carry a very large current if energetically cooled by the circulation of a liquid. By using a liquid of very low temperature the current could be further increased on account of the increase of conductivity of the metal both for electricity and for heat.

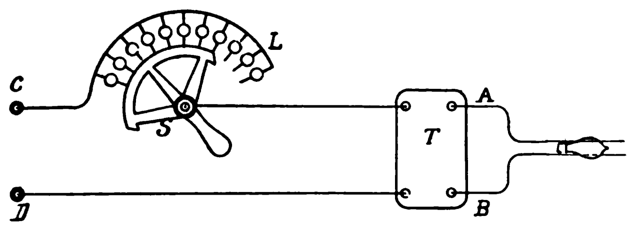
As I have not an opportunity to make such experiments myself, I write these short notes with the hope that some one more fortunate than I will find a way of determining what takes place under these conditions, and that he may draw interesting conclusions therefrom.

NEW METHOD OF CURRENT SUPPLY FOR CROOKES TUBES AND FOR TESTING INCANDESCENT LAMPS FOR VACUUM.

BY C. M. GREEN.

I AM now using some apparatus for lighting vacuum tubes and testing the vacuum in incandescent lamps which two months ago I considered impossible to operate, namely, an alternating current of less than 2,000 volts in connection with an ordinary transformer. The apparatus is in the hands of many central station men, especially those who have an alternating current system of lighting.

All the apparatus necessary is a few incandescent lamps, an ordinary commercial type of transformer and a supply of the secondary alternating current. I have been using Thomson-Houston oil transformers, type F, wound for 2,000 volts primary and 50 or 100 volts secondary. One of 300 watts capacity is of sufficient size for this purpose. The object of the bank of lamps is to be able to vary the voltage at will by turning them on or off. The accompanying diagram shows the manner in which the apparatus is disposed.



GREEN'S METHOD OF TESTING FOR VACUUM IN INCANDESCENT LAMPS.

To the transformer, T, the leads, A and B, are connected at the primary terminals, or rather the fine wire terminals which are used in this case as the secondary side. To the other side, which is the heavy wire winding the current, supply is connected, first passing through a bank of lamps, L, as shown, by means of the switch, S.
which is the heavy wire winding, the current supply is connected to the tube, and for testing incandescent lamps, rods connected to the same terminals are held at each side of the lamp bulb. The writer has also found this apparatus very useful for testing insulating joints or couplings for combination fixtures and electroliers.

ON A ROTATIONAL MOTION OF THE CATHODE DISC IN THE CROOKES TUBE.[1]

BY FRANCIS E. NIPHER.

IT is well known that the equations which represent the properties of the magnetic field external to a conductor, are inconsistent when applied to points within the body of the conductor. Maxwell disposes of this absurdity to which the equations lead, in the single sentence which closes section 606 of his "Electricity and Magnetism." He says: "Within the substance of the conductor, there is no such thing as magnetic potential."

It has long seemed to me that this failure of the equations must be the result of leaving some elements of the problem out of the discussion. I have spent a great amount of time in seeking for some rotational phenomenon hitherto unrepresented in the equation. Until recently the results were wholly negative. While recently experimenting with a Crookes tube I observed that the circular aluminum disc of the cathode became slightly loose on the aluminum wire, and that it was constantly rocking in rotary motion on the wire. After several days of use, during which it had been decided to construct a tube with discs capable of rotation, the cathode disc suddenly became loosened, and began to rotate slowly on the wire as an axis.

The bearings were somewhat rough, and the disc was not perfectly balanced. It often stopped, but then began to rock against the obstacle until it again freed itself. The direction of rotation was contrary to the hands of a clock, when the disc was viewed from the point where the cathode wire pierces the wall of the tube. All attempts to accelerate or retard the motion by means of strong bar magnets, as in Barlow's wheel, were without effect. Placing the tube at various distances from the induction coil and giving the disc all possible positions in the earth's field, produced no change in the rotation. A more decided rotation was produced by using the brush discharge of a 24-inch Holtz machine. No rotation has been produced as yet when the leading wires were in metallic contact with the conductors of the Holtz machine, but when the leads consisted of rods having spherical terminals, separated by short spark intervals, the rotation was always seen. When the loose disc was made the anode, no tendency to rotation has been observed. Thus far all attempts to produce the effect in air of ordinary pressure have failed, but the work in this direction is not yet concluded.

In the tube used, the tendency to rotation was not observed until by long use the vacuum had become very high, and it has now nearly reached the limit where the sparks pass around the tube, rather than through it.

The leading-in wires are at right angles to each other in the tube used. Tubes are now in preparation which will have rotary discs facing each other as well as at right angles to each other, and various other features, by which it is hoped that many questions which at once suggest themselves may be answered. There is much reason to suspect that the gas particles do not shoot off normally from the surface of the disc, but in a vortex, the axis of which is in the two dark spots opposite the cathode faces. The fact that the anode does not respond, and that similar experiments in open air have thus far failed seems to point to the cathode discharge as the direct active agent. This view is not easily reconciled with the result of the experiment made by Crookes with the hemicylindrical cathode ("Nature," July 3, 1879, p. 229, Fig. 3), but the figure shown does not seem to quite agree with the description of it. Experiments are now in preparation which will decide this question. It is possible that the rotation observed is a direct action and reaction between the current in the disc, and the external field due to the current. In this case the rotation apparently ought to be producible in open air, and on the anode terminal of the Crookes tube.

Whatever may be the direct agency producing this rotation, it seems apparent that we now have an experimental basis for imposing a term representing a rotation into the equations representing the conditions within a conductor.

[1]Read before The Academy of Science of St. Louis, May 4, 1896.

THE STANDARDIZATION OF LAMP SOCKETS.[1]

BY ALFRED SWAN.

THE topic which I introduce deals with the vexed question of lamp sockets. Its object is to promote an interchange of opinion on the part of those present who are interested in the subject, and by its discussion before this convention give to the question that status which its importance demands.

This question of the standardization of the lamp socket was recently raised by The Electrical Engineer, and various letters appeared in that journal on the subject. A notable feature of that correspondence was the preference, almost unanimously declared, for a particular type of socket because of the comparative cheapness of its lamp base.

The fact that a socket outlives many lamps does, undoubtedly, as things now are, encourage the use of that particular type of socket which is useable with the least expensive form of lamp base, though the socket in question may not in itself be the best or the cheapest. This fact would seem clearly to indicate that, preliminary to the standardization of the lamp socket must be the standardization of the lamp base. When scientific fitness, due simplicity and point of lowest cost shall have been attained in regard to the lamp base, then will, necessarily, result a standard socket.

[1]Remarks addressed to the N. E. L. A. May 5-7, 1896.

Following, therefore, this line of argument and concerning ourselves first with the lamp base, let us, with due reference to its functions, consider what we should demand in a standard lamp base.

The elements involved in this question are threefold—electrical, mechanical and economical. Good insulating conditions are of the first importance, to guard against leakage, or other abnormal action, in the wires connecting with the lamp. Mechanical considerations concern the means by which the base is attached to the lamp—as well as the means by which, when so attached, it couples with the socket. The method of coupling with the latter, while insuring a rigid and unfailing contact, should be such as not to put an undue strain upon the lamp. Cheapness is, of course, a sine qua non.

The death rate in lamps, as compared with sockets, being high, and the base, as a rule, not surviving the lamp, obviously the less value we involve in that base the better. How many of the present types of lamp base conform to these standard requirements? What could well be more inappropriate to the delicate structure and graceful form of the lamp itself than is even the best—or rather, let us say, the least objectionable—of those appendages with which lamps are now encumbered.

In addition to their offending in this respect they are objectionable in that they involve the use of plaster, which we know is bad, electrically considered. Their large size renders them heavy and clumsy; sockets are, therefore, similarly clumsy; and, to sum up, all are needlessly expensive, the cheapest costing not less than $6 a thousand, while, I am fully warranted when I assert that one-third of this sum might, and eventually will, provide a suitable and appropriate fitting.

Manifestly, therefore, a standard lamp base must be the first point for determination—a standard not merely accepted as such, but one that by virtue of its essential merits shall be fairly and fully entitled to such recognition—a standard that shall accomplish the nearest approach to finality possible in that direction.

Having accomplished that, the rest necessarily follows; a lamp base involves a socket to suit it.

Having got the best and cheapest lamp base that is possible, no other, in time would be used, and hence, as a corollary, we arrive at our standard socket.

I am not unaware of the revolutionary character which, in some of its aspects, this movement may appear to assume, nor do I fail to appreciate the practical difficulties which necessarily confront any and every attempt to cope with this standardization question. But, I submit, where the need for amendment is so palpable and the call for that amendment so imperative, as in this case it is, difficulties must needs be met and overcome. This is not a question for solution by mere process of elimination or survival—in which case it might be left to work its own cure; it is in my opinon a matter involving radical change and a new departure.

In view of the fact that high tension lamps are in all probability going to be the rule in the future, the question of a safe socket acquires enhanced importance. Porcelain will, no doubt, come largely into use for that purpose, and this will greatly modify the conditions now governing the lamp base, and will make possible that simplification and economical change in this regard which I have already indicated; and, as even a small saving on the cost of a base becomes a considerable item in the aggregate, it is in this direction, therefore, that economy and improvement should be most encouraged.

In this connection I might mention that the idea lately occurred to me—and I since find that others have put forward the same idea—to engineer this matter economically by means of a detachable form of base—a form of base, that is to say, admitting of repeated and continuous use, thus saving expense on renewals.

I have come to the conclusion, however, that that idea, though apparently all right in theory, would not operate satisfactorily when reduced to commercial practice—for, even were this re-use made possible by returns on the part of customers —and this is very doubtful—the allowance necessary to induce those returns, added to shipment and other charges, would go far to neutralize any saving there might otherwise be.

Regarded from the commercial standpoint, therefore, I come to the conclusion that the most practical and satisfactory solution of the matter is a form of the base, or mount, so inexpensive that when the lamp is destroyed the base may be allowed to go with it, as in itself a thing of no value. And it is to this form of base that I allude in the foregoing, and to which I shall, later, more particularly refer. In practice all lamps would, in such case, be fitted at the time of their manufacture with this inexpensive mount and would so be stored, complete and ready for shipment at a moment's notice, the manufacturer, the supplier and the consumer all participating in the advantages that would certainly attend this simplified order of things. The commercial benefit that would undoubtedly follow in the train of this standardization of the lamp alone makes that end worth striving after, for, that the present complicated and vexatious state of things operates to retard the progress of electric lighting, and is therefore detrimental to its industrial interests, cannot be denied.

But the purpose of these remarks is not, at this moment, the advocacy of any specific form of base or socket. That will follow. Their object, as stated at the outset, is to take the sense of this representative gathering, first upon the main question at issue —that is, the question as to the desirability of a standard socket—and next, should that question be affirmatively met, to determine, if possible, a line of action that shall best conduce to the desired end.

But, in conclusion, I would urge that any resolution on this question at which this convention may arrive, shall not lose sight of the fact that a standard base is the kernel of this matter; not merely a base chosen as a standard from one of the prevailing types, but a base which is yet to be evolved—one that shall in all respects fulfill standard requirements and so give us as its complement our standard socket.

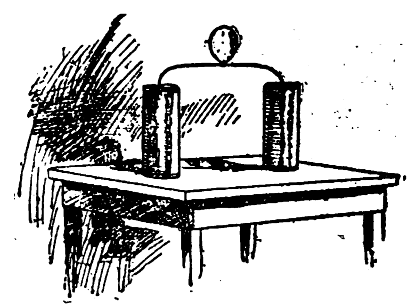
THE TESLA VACUUM LAMP.

DURING the past week Mr. Tesla has announced in various interviews with the reporters of the daily press that he has effected improvements in the methods of vacuum tube illumination announced by him in 1891. Speaking to a New York "World" reporter, Mr. Tesla is quoted as follows:

"There has been little change in the apparatus I now use compared with that I displayed at St. Louis. The basic principles are the same. I have simply made improvements and marked advances. I have found the causes of loss of energy and have largely overcome them. Already I can deliver 10 per cent. of the initial energy in a pure white light. This is three times the efficiency of an ordinary incandescent lamp."

The New York "Herald" of May 24 gives the following description and illustration of Mr. Tesla's improved lamp:

"It is a very simple looking contrivance. Two brass cylinders, looking for all the world like the empty shells of shot for a rapid fire cannon, stand about six inches apart. A light



THE TESLA VACUUM LAMP.

wire extends between the two, which probably contain coils, but about them Mr. Tesla will not say a word. Directly in the center of this thin wire is an ordinary electric light bulb used for incandescent lighting. The little point usually at the bottom of the bulb points upward. There is no filament in the vacuum. It appears merely as an ordinary bulb would appear if the carbon filament had been destroyed, but the interior has been exhausted of air many times more than the incandescent light bulb. When the current is turned into the electrodes and so into the bulb there is no foreign substance to burn. The electric molecules have the vacuum all to themselves. They move at the rate of from 3,000,000 to 4,000,000 vibrations a second. No one point gets bright and then seems to ignite the rest, as in the bulb usually seen. There comes a glow, just as there is a glow in the eastern sky at dawn, and then it becomes rapidly intenser, until the whole interior of the bulb sends out light, just as though a piece had been cut out of the edge of the sun and packed into the little glass receptacle."

According to the account in the "Herald" this lamp, with the same cubic contents as a 16 candle-power incandescent lamp is of 250 candle-power capacity.

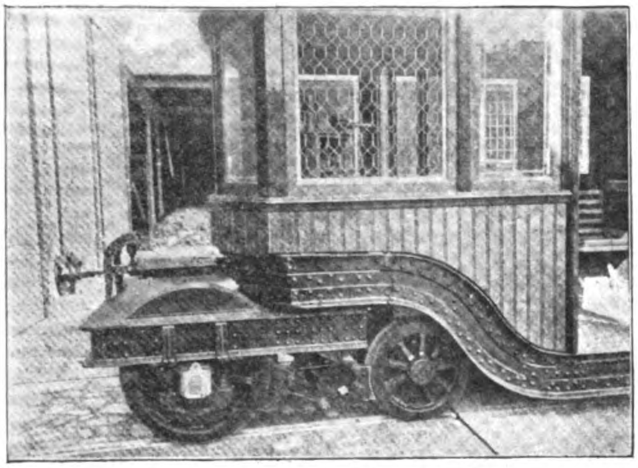
PROF. R. O. HEINRICH, formerly of Lehigh University, and of late years with the Weston Electrical Instrument Company, has gone to Europe to take up his permanent residence in Berlin as the representative of that company, for whose admirable apparatus the demand in England and on the Continent has grown to very large proportions. Prof. Heinrich during his long residence in America has won a host of friends and admirers who wish him all manner of success and prosperity.

ELECTRIC TRANSPORTATION.

THE BUDA-PESTH UNDERGROUND RAILWAY.

A NEW underground line has been constructed under the residential streets of Buda-Pesth. The whole track had to be done on the cut and cover system, and its cost was over 1,000,000 florins per kilometre. The line is double track throughout, and will be opened for traffic, it is believed, next month. The stations are only 400 metres apart, and it is intended to run the cars at a maximum speed of 40 kilometres an hour. A novel system of speed regulation has been adopted, the object of which is to do away with the necessity for any intelligence on the part of the motorman. The motorman can only cut the motors in and out, but cannot regulate their speed, this being done automatically. A solenoid is connected to the brush terminals of the motor on the car, and as the counter electromotive force increases, so does the magnetism of the solenoid. The device is extremely ingenious, and it can be regulated in such a way as to practically fix the distance in which the car will attain its maximum speed. Electric brakes are also used, similar to the Sperry brake.

There are two motors on each car, they also being used for braking by short-circuiting them, and making them work as



TRUCK AND CAR FRAME OF BUDA PESTH UNDERGROUND ELECTRIC RAILWAY CAR.

generators. The height of the tunnel from the top of the rail is 2.85 metres; the tunnel could not be made any higher, as otherwise it would have been lower than the level of the Danube, and that would have increased the expense of construction enormously. The cars have been specially built; each car is mounted on two bogies, shown in the illustration taken from the "Electrical Review," London, and inside they are exceedingly handsome, and look more like the saloon of a yacht than a tram car. There are 29 seats, and there is room for 15 to stand up. The total weight of a car when empty is 12 tons. One 50 horse-power motor is mounted on each truck.

The line was built and equipped by Messrs. Siemens & Halske, of Berlin. The current is taken from an overhead conductor, which is fixed to the roof of the tunnel by means of cast iron shoes. The tunnels and the stations are all lined with glazed tiles. The line was constructed with the object of connecting the system of tramways which encircles Buda-Pesth with the center of the city. Tramways were not possible, as the town authorities would not allow any rails to be laid down along the streets of the residential quarters through which this line would have had to pass.

COMBINED NAPHTHA AND ELECTRIC LAUNCH.

"Forest and Stream" says: Commodore Rouse, Seawanhaka Corinthian Y. C., will this season test a novel combination of naphtha and electricity on the flagship Iroquois. The yacht's naphtha launch, one of the regular boats built by the Gas Engine and Power Company, will be fitted with a special dynamo that can readily be shipped aboard and connected to the engine. When the launch is not in use during the day, and lying at the boat boom, the dynamo will be put aboard and connected and the engine started up, the wheel revolving in the water. The electric current will be used to charge the storage batteries aboard the yacht which supply the electric lights with which she is fitted throughout. When not in use the dynamo will be stowed below on the yacht. How the arrangement will work in practice is yet to be proved.

CAN ELECTRICITY SUPPLANT THE STEAM LOCOMOTIVE ON TRUNK RAILWAYS?—XIII.

(*Concluded.*)

Wm. Baxter, Jr.

COST OF ELECTRICAL EQUIPMENT FOR THE PENNSYLVANIA RAILROAD SYSTEM.

POWER REQUIRED.—In order to etsimate the cost of an electric equipment for the Pennsylvania Railroad it will be necessary to determine the amount of power required. This we can do by several different processes, and from the results thus obtained, by making proper allowances for the probability of error in each case, can arrive at a figure that will probably not be very far from what we would obtain if possessed of data more directly applicable to the case.

We can obtain from Tables 7 and 8 the total number of miles run per year by all trains, and by reducing this to the hourly traffic and multiplying by the power required per train, as already worked out in a previous paragraph, can deduce a figure for the total power necessary to operate the road. We can obtain another result by taking the yearly movement of freight and passengers and reducing it to an hourly basis with the proper allowance for weight of cars. The data for such a calculation are also contained in Tables 7 and 8.

Another estimate can be made by taking the number of locomotives and multiplying by the average power developed by each, making, of course, a proper allowance for engines not in use. Finally, we can take the coal consumption and determine the power from this by assuming a certain consumption per horse-power hour. Taking the first case we would have:

Miles run per hour by passenger trains	2,982
Miles run per hour by freight trains	4,080
Miles run per hour by switching trains	2,059
Miles run per hour by construction trains, etc.	191

These figures are based upon the assumption that the miles run on Sundays are much less than on week days, and also that the movement of trains is not uniform, but that at some hours of the day it is much heavier than at others. The daily average has been taken as equal to the yearly run divided by 330, and the hourly mileage as equal to the daily divided by 15.

We can get the number of trains in motion at any time from these figures by dividing the hourly total run in miles by 30 for passenger trains, and by 15 for freight and all other trains. We would then have the following as the number of trains in motion:

Passenger trains	99.4
All other trains	422

Assuming the average power required to move passenger trains to be 350 horse-power and for freight trains 250 horse-power, we would have for the total power required:

	Horse-power.
To move passenger trains	34,790
To move all other trains	105,500
Total	140,290

Calculating the power by the number of trains (see Tables 7 and 8), which is a short way of obtaining the second estimate, we would have, by changing from a yearly to an hourly basis, in the same way as in the preceding case:

Passenger trains, per hour	77.9
Freight trains, per hour	94.2

As the average number of miles run by passenger trains is about thirty-four and by freight trains forty-five miles, as obtained by dividing the train-miles by the number of trains, it follows that each passenger train is in motion for 1.13 hours, and each freight train for three hours, from which we would get:

Passenger trains in motion at one time	$77.9 \times 1.13 = 88$
Freight trains in motion at one time	$94.2 \times 3 = 282.6$
Other trains in motion at one time	141.3

The switching trains have been assumed to be equal to 50 per cent. of the freight, as the mileage of the two is in about that proportion.

Estimating the power per train as before for freight and

passenger service we would have the following results, which are but slightly different from the first:

	Horse-power.
Power for passenger trains	30,800
Power for all other trains	105,975
Total	136,775

Estimating by the number of locomotives we will get the following: Number of passenger engines in use, 80 per cent. of the whole number, equal to 382. Average miles per year, 39,000; which, at the average speed of thirty miles per hour, equals 1,300 hours in motion per year, or, 3.93 hours per day. Therefore, the total hours of service per day of the 382 locomotives amount to 1,404 hours, which, divided by 15, gives 93.56 as the average number of passenger engines in use at one time.

Taking the freight engines, we have 827. The average miles per year, 23,100; divided by the speed, 15 miles, equals 1,540 hours per year, or 4.66 hours per day; 827 × 4.66 divided by 15 gives 256 freight engines in use at a time. In the same way we get for switching engines 151.4 as the number in use.

From this calculation we have the following number of locomotives in use at a time:

Passenger	93.56
Freight	256
Switching, etc.	151.4

Figuring the power as in the previous calculations, we have:

	Horse-power.
For passenger trains	32,746
For all others	101,850
Total	134,596

Estimating the power by the coal consumption we will get (by basing the calculation on the amount used by each class of engines, as determined in previous calculations, and taking the coal consumed per horse-power at 4.6 and 10 pounds, respectively, for passenger, freight and switching engines), the following results:

	Horse-power.
Power for passenger service	48,450
Power for freight service	78,833
Power for switching service	20,290
Total	147,573

Of these four estimates the last is the largest, and is also the one that in all probability is the most accurate, although not necessarily so. If the efficiency of locomotives is as high as we have assumed it to be, then this estimate cannot be very far out of the way; but the fact that the estimate is higher than any of the others, instead of showing that the figures are not as reliable, may in reality show that the coal consumption of locomotives is not as low as we have assumed it to be.

The figures obtained above represent the average power of the average day during the hours when traffic is the heaviest, but there are seasons in the year when the traffic is largely increased, and hours of the day when the demand for power is considerably more than has been allowed for. To meet these unusual demands we should increase the power about 25 per cent. to allow for the increased traffic at certain seasons of the year, and again another 25 per cent. to meet the heaviest demand during the day at such times. Making these allowances we will have.

	147,573	horse-power.
+ 25%	36,894	
	184,467	
+ 25%	46,118	

Grand total, 230,585 horse-power

This is the amount of power that would have to be delivered on the track, and if we assume the efficiency between the steam engine shaft in the power station and the car axle at 60 per cent. we would require about 385,000 horse-power steam engine capacity in the power stations.

As there are 2,656 miles of road, the average power per mile would be about 145 horse-power. As there are about 350 trains in motion at a time, without counting switching trains, the average distance between trains would be 7.58 miles. As the average power required for each train is about 300 horse-power, it follows that the capacity of stations would have to be small unless they were located at long distances from each other. But the requirements of the road would not be properly met with stations of small capacity, because, although the average power of a locomotive is not very great, some of the express engines may draw on the source of energy for a thousand, or even more, horse-power. It, therefore, is evident that whether the points from which distribution is made are close together or far apart, there must be considerable reserve capacity. This indicates at once that the higher economy of installation demands that the stations be placed as far apart as practicable.

By making use of rotary transformers each station can be made to supply forty-five miles of road without an undue expenditure of copper. Dividing the road up into sections of this length, the total number of stations required to operate the entire system would be sixty. The average number of trains drawing energy from a station would be less than six.

In each station current at, say, 700 volts would be generated to feed the trolley circuits for a distance of seven and one-half miles each way; other currents of, say, 5,000 volts would be transmitted to rotary transformers located fifteen miles from the station in both directions. These rotary transformers would generate a current of 700 volts that would pass directly to the trolley circuit. Each transformer would supply fifteen miles of trolley line, and the station proper another fifteen miles, making in all forty-five miles of road that would be operated from each station.

In this arrangement two-thirds of the current energy would be transmitted fifteen miles under an electromotive force of 5,000 volts; it would then be converted into a current of 700 volts and transmitted an average distance of three and three-fourths miles. The remaining third of the energy would be distributed under an electromotive force of 700 volts at an average distance of three and three-fourths miles.

The capacity of each station would be 385,000 ÷ 60 = 6,500 horse-power.

	Horse-power.
Maximum working capacity	8,000
Average output	4,000

The following figures give the cost of each station, with its two sub-stations and the trolley lines and feeders for forty-five miles of road. The capacity of lines is calculated to give an efficiency of conversion of 60 per cent., with an output of 4,000 horse-power on the assumption that the generators will give an efficiency of 92 per cent., and the rotary transformers 85 per cent., working at this capacity. As the average number of trains per section is less than six, and as the average power required for each train is about 300 horse-power, or 500 at the station, the actual average output should not be over 3,000 horse-power; therefore, the amount of copper allowed in the following estimate will be sufficient to render a 60 per cent. efficiency certain under all ordinary conditions of working.

COST OF TROLLEY LINES AND FEEDERS.

Trolley	$40,000
Feeders	160,000
Material, other than wire, and cost of constructing trolley lines	135,000
Cost of construction and material for feeder lines	60,000
Total	$395,000

COST OF STATION.

Steam plant	$100,000
Electric plant	85,000
Building	15,000
Total	$200,000

COST OF SUB-STATIONS.

Converters	$30,000
Buildings, $1,000 each	2,000
Total	$32,000

From the above we have:

Cost of line	$395,000
Cost of station	200,000
Cost of sub-stations	32,000
Grand total	$627,000

The total cost of sixty stations, or the cost of equipment for the entire line, would be $37,620,000. To this must be added the cost of motors. These should not exceed $6,000 per motor car. As to the number that would be required to take the place of 1,800 locomotives now used, there may be room for difference of opinion. The advocates of steam may claim that it would require as many motor cars as there are locomotives, but inasmuch as the mileage of the latter is only about one-third that of what we know could be obtained from the former, we would be justified in saying that 600 motor cars would be enough, and such would be the case if the schedule of trains could be so arranged as to keep the motors running the greater portion of the time; but, probably, this could not be done. Therefore, we will take a medium course and assume

that 1,000 would be required. We would then have for the cost of motors $6,000,000, and for total electric equipment of Pennsylvania Railroad system $43,620,000.

This estimate is only a rough approximation; anything more in detail or more accurate could not be given unless we had full information as to amount of traffic over each mile of road, location of curves, grades, etc. Even were such data available, the labor involved in working out a complete estimate, covering every detail, would be such as to preclude the undertaking.

Although the figures we have obtained above are only approximate, they are undoubtedly much nearer to the actual cost than a mere good guess, and enable us to form some idea of what the transformation of a large trunk line railway system from steam to electricity would involve in the way of expenditures; and by the aid of investigation of the cost of operation previously made, we can see whether the saving would justify the outlay. In order to complete the data that will enable us to draw conclusions, we will give an estimate of the cost of operating the power stations and maintaining the line. The cost of coal and the repairs to motors were included in the investigation of the saving in expenses of operating the road; therefore, all we have to consider here is the cost of labor and repairs to line and station machinery.

Cost of operating one station and forty-five miles of trolley and feeder lines:

Chief engineer, per year	$2,000
First assistant engineer	1,800
Second assistant engineers (2)	3,000
Firemen (10)	5,000
Helpers (4)	2,000
Linemen (12)	7,200
Oil, etc.	1,000
Total for wages, etc.	$22,000
Total for wages for sixty stations	$1,320,000
Repairs on $37,620,000 at 4 per cent	1,404,800
Grand total	$2,724,800

As the allowance for repairs is only 4 per cent., it may be considered by some as very low; but experience shows that on some of the apparatus even this rate is too high. The repairs on large engines are less than 4 per cent. per year, and on generators are not much over 2 per cent. On boilers they are over 4 per cent., and as to the repairs on the line it must be remembered that the wages of linemen should properly be charged to this item. Considering these facts it must be conceded that 4 per cent. on the entire cost of stations and line is over rather than under the actual cost.

Going back now to the estimate of the saving in operating expenses, we find that the figures were $7,606,442.24. Deducting from this the cost of wages and repairs on stations and line as just obtained—which is $2,724,800—we have as the net saving $4,881,642.24, and as the total cost of the electrical equipment would be $43,620,000, this saving would amount to more than 11 per cent. on the investment.

As already stated, economy of operation is not the only claim of superiority that can be made for electricity. We have also shown that it can be made safer, and that much higher speeds can be obtained, because the power that can be developed by an electric motor is practically unlimited, while that of a locomotive is not. The comfort of the traveling public would be increased, because the cars would be surrounded by pure air, while trains drawn by locomotives, especially when running at high speeds, are enveloped in an atmosphere largely composed of the products of combustion.

If the claims herein made are well founded, electricity would prove cheaper and safer, would increase the comfort of passengers, and render more rapid transit possible. Such being the case, why should it not supersede steam? If railroad managers were convinced that these claims are true, a transformation of their lines would at once be undertaken; but they are not convinced, and will not be until they learn the facts in their own way, and that way will be by going slowly, and trying a branch road here and another there, until they have obtained a sufficient amount of data from actual experience to dispel all doubt. When that point is reached the transformation will be rapid, and the complete invasion of the steam railway field will take place at a pace equal, if not greater, than that of the street railways. Already, the New York, New Haven and Hartford, and the Pennsylvania Railroad, are feeling their way by experimenting on branch roads with light equipments. This work will no doubt be followed up by the equipment of more important branches with heavier rolling stock, until a sufficient amount of practical data is obtained to justify a change of entire systems. This same course will in all probability be followed by other railroads, and if so, electricity may gain a strong foothold on trunk line railways much sooner than its most sanguine friends expect.

LETTERS TO THE EDITOR.

EFFICIENCY OF THE JACQUES CARBON CONSUMING PRIMARY BATTERY.

IN the description of the "Jacques Carbon Consuming Primary Battery" given in The Electrical Engineer of May 13, some very interesting facts are stated. There are doubtless other facts concerning this battery that would have been interesting if stated; for example, the amount of carbon consumed outside of the pots. That carbon is "consumed" in this battery, particularly in the furnace part, there can be no doubt. But that the apparatus is a primary battery is not quite so certain.

The statement is made that to maintain a current of 16 amperes at 90 volts in a series of 100 cells for 18¾ hours required the "consumption in the pots of about 8 pounds of carbon." The most important part of the carbon, that consumed outside of the pots, is not stated. It is probably safe to say at a guess that the amount consumed outside of the pots is at least many times as great as the amount consumed in the pots. Why the efficiency of 82 per cent. should be calculated on the small amount of carbon consumed in the pots, while the comparatively great amount consumed outside is ignored, does not seem very clear. If there is any evidence to prove, or reason to believe, that the electrical energy came from the carbon consumed in the pots, and not from that consumed in the furnace, a statement of that evidence would also be interesting.

It seems to me, from the data given and the description of the apparatus, that, instead of being a primary or galvanic battery, it is purely a thermo-electric battery; that the consumption of carbon in the pots, instead of being the source of electrical energy, was a result caused by the thermo-electric current, which originated in the heat of the furnace, that is, in the carbon consumed outside of the pots.

My reasons for this belief are the following:

1. The iron pot and carbon rod joined by the fused sodic hydrate constitutes a very powerful thermo-electric cell. (Vide Jenkin's "Electricity and Magnetism.")

2. The thermo-electric current of this cell must necessarily pass through the electrolyte connecting the carbon and iron, and cause oxidation by electrolytic action.

3. The current obtained by Dr. Jacques, 30,000 ampere hours, is electro-chemically equivalent to 7.5 pounds of carbon. But it was obtained from eight pounds of carbon "consumed in the pots." Hence, if the energy came from this carbon by galvanic oxidation the current efficiency was $\frac{7.5}{8}$ = 94 per cent., which seems rather high.

C. J. REED.

AFTERGLOW IN LAMP FILAMENTS.

I have an ordinary 16 candle-power, 52 volt lamp, which to me is a curiosity. It burns with its usual current and voltage in the ordinary manner, but as soon as the current is shut off by means of the key socket, the lamp, when grasped firmly in the hand, gives out from its filament a soft blue light of a phosphorescent appearance. Having had several years' experience in incandescent work, and in handling lamps of various makes, and, never having seen anything of this kind before, I am anxious to know the cause of the phenomenon.

Hoping that you or some of your readers may take the trouble to explain this to me, I am,

O. C. R.

Woburn, Mass.

STANDARDIZING INCANDESCENT LAMP SOCKETS.

My attention having been drawn to a letter under the above heading, from Mr. F. R. Upton, in the "Western Electrician," I am led to reply because of what I conceive are the inconsequential conclusions of that letter.

This question has been raised, and is being debated, not in the interest of standardization merely, but to the end also, and not less, that the right thing be standardized.

Because a certain style of lamp base happens to be more largely employed than any other, to argue that, therefore, that style should receive permanent indorsement is wholly to miss the purpose and object of this movement; for, even were the base here referred to the best of any now in vogue—which is a question—it cannot for a moment be contended that it is the best possible, or that it fulfills the requirements of a standard.

In the consideration of this question, with a view to its settlement upon a permanent basis, the extent of which any of the present types have been, or are being, used, is a matter of trivial importance in comparison with the object of having, in the end, the right thing.

ALFRED SWAN.

New York, May 15, 1896.

THE

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CONTENTS.

VACUUM TUBE LIGHTING.

NOT since the days when the Edison incandescent lamp was first announced as a practical commercial illuminant has the public, both electrical and lay, been stirred as it has during the last few weeks by the practical demonstration which Mr. Moore has been giving of his method of vacuum lighting at the Electrical Exposition. The daily press from one end of the country to the other has taken up the subject and aroused an interest which cannot but be of benefit in the long run to the industry at large. But, perhaps, the most important development within the week has been the establishment of the accuracy of the figures of the power expended in the Moore tubes, which had been called in question in various quarters. It will be recalled that in the demonstration which Mr. Moore gave before the American Institute of Electrical Engineers the twenty-seven tubes employed by him on that occasion, as announced in The Electrical Engineer, required little more power than an equal number of 16 candle-power incandescent lamps. Through the unfortunate manipulation of the motor furnishing power to operate the apparatus, the impression was gained by many present that the 7½ horse-power motor employed was laboring under great difficulties to carry the load imposed upon it, and in spite of the figures published in The Electrical Engineer there were many who still remained skeptical. In the discussion which took place before the American Institute of Electrical Engineers last week an opportunity was afforded for an expression of opinion and the lack of any information on the subject of power consumption in Mr. Moore's paper constituted the principal argument of several of the speakers. This criticism, it cannot be denied, was a just one, but the results of actual tests made on Mr. Moore's apparatus by one of the editors of this journal, and which are given in another column, showed that Mr. Moore's original figures were quite conservative. Even these tests were criticised on the score that the instruments employed may not have been adapted to the peculiar nature of the current with which Mr. Moore operates. The doubt here expressed must also be conceded to have been a proper one, and Prof. Anthony's suggestion that the energy consumed by the tubes be estimated by the power developed on the motor side of the combination was an eminently timely one. It is a matter for congratulation that its author followed up the suggestion by an actual test in the manner proposed by him. The results of that test, which we print on another page, demonstrate amply that the figures given by Mr. Moore, and by the editor of this journal, were well within bounds, and, indeed, if they erred at all, did so on the side of safety. The test of Prof. Anthony and Dr. Nichols and their associates show that the Moore vacuum tubes each consume a fraction over forty-nine watts, and this on the assumption that the efficiency of the motor and dynamo combination was 80 per cent., which is certainly high for the size of the motor and dynamo employed.

We cannot but express our gratification at the fact that all further criticism on the lines above referred to must now be set at rest. We have little doubt that Mr. Moore will be able, with further experiments, to show even far better economy of power than any he has thus far shown. This opinion seems justified on the observed fact that some of the tubes tested as

low as 30 watts, and also on the evident fact that the energy actually contributing to the illumination of the tube must be but a small fraction of that absorbed by the coils whose reactive effect serves to produce the electrical disturbances in the tubes. That the results obtained by Mr. Moore have given a marked impetus to vacuum tube lighting, is evident by the fact that Mr. Tesla, after five years of neglect, has taken up the subject, and claims to have made considerable advances over the results obtained by him when he first electrified the scientific world with his brilliant high frequency experiments. We use the word neglect in reference to Mr. Tesla advisedly, for we have far too high an opinion of his genius to believe that even a small portion of that time devoted by him to vacuum tube work would not have resulted in a substantial advance at his hands. Even Mr. Edison, who seemed to have cut adrift from electricity during the past few years, has, we understand, also taken up the subject, and promises to show a vacuum lamp before the close of the Electrical Exposition. This lamp, we understand, will embody a phosphorescent material as the principal light-giving factor. All these facts combine to show that the time cannot be far distant when vacuum tube lighting will enter upon its career of commercial usefulness. Mr. Moore has undoubtedly set the pace, and pushed the vacuum tube lamp forward an enormous step toward its commercial utilization.

While the efforts at devising a practical vacuum tube lamp are thus being pushed with vigor, we cannot but express our regrets at the unseemly controversies, not to say bickerings, into which rival inventors in this field have allowed themselves to be drawn in the daily press. The public, it is true, is a party in interest to all advances in the arts, but surely nothing can be gained by airing before the world at large petty jealousies and criticism not backed up by facts. On the contrary, such proceedings can only serve to cast discredit on all alike. We may be permitted to suggest that in this case as in similar advances, it is works, and not words, that count.

SYSTEMS, SPECIALIZATION AND STANDARDS.

SUCH a fine and remarkably varied collection of apparatus as that now on view at the National Electrical Exposition invites to many reflections, and suggests many thoughts. Some of the lessons of the show we have already ventured to point out during the past few weeks, and now, as the exposition draws to a close, it may not be inappropriate to touch upon some further considerations. Chief among these is certainly the evidence that the show affords of the breaking down of the old "system" and the irresistible tendency toward specialization.

There was a time, and not so long ago, when all the developments of electric light and power were summed up in the word "system." If anybody brought new apparatus on the market, it had to be completely of that make from the first nut to the last binding post. A mere lamp or a mere dynamo counted for worse than nothing. You could either take the "system" or leave it, but your name was anathema and "mud" if you ventured to put one man's lamp on another man's machine; and all the terrors of the damned were in store for those who thus "infringed." The echoes of those barbaric old days are still in the public ear. We all of us still use the phraseology of that feudal period, and are still inclined, from force of habit, to look askance at a device built to be good solely of and for itself, as the sole end of its being, and appealing for patronage solely on merit. But the times have changed. The General Electric Company to-day, perhaps better or worse than any other concern, represents the exploded idea that you must not buy a single thing that the "parent" company does not make; and its gigantic failure on those lines of monopoly is apparent to all the world, for there is hardly a product, except some heavy stuff, in regard to which the General Electric Company is not frequently surpassed and often beaten clean out of its boots by the independent specializing manufacturer.

The local companies, the owners of isolated plants, and the municipalities, all recognize to-day the value of this specialization, and even this week the division of the big order from the city of Chicago indicates the positive trend of events. There was a period when the crudeness of the art rendered the "systems" a good thing, except that there was such an infinite variety of them; but now the "systems" have crumbled away in ruin, except in a few specific instances where the word applies legitimately to certain specific narrow lines of apparatus or method.

No one can deny that the art is not gaining immensely by this change from a grouping where the company that built locomotives also made watches—so to speak—to a separation by means of which a number of concerns have sprung up modestly capitalized, well equipped, and ably manned by talent exerting itself on the things best suited to respond in a perfect product. We may be wrong, but to our way of thinking the whole future and prosperity of electricity lies in the continuance of this process. Even in so recent and new a field as the utilization of electrical heat, specialization has begun. Obviously it will pay inventors to take up individual ideas and hammer them out into new arts. Electricity as a field of work now has an enormous stock of principles and ideas. What we all need are the arts that embody them.

And this brings us to the point that a need of the hour is standards. Take the one subject of light, and see what a variation there is in units, in measurements, in lamps and every other branch of the matter. Take even fan motors. Except that they have to run on predetermined voltages, which does enforce that much of uniformity, there is an utter welter of variation in every other respect. Now, with good standards, every article would be gauged by them and then more than ever merit and quality would tell. "Standards" are the very antithesis of "systems," as the latter word was once understood.

THE NIAGARA TRANSMISSION.

IT is a pity that a hasty piece of journalistic work should have been allowed to mar the general harmony and success of the exposition, and should have evoked the indignation that is naturally aroused when innocent persons are blankly accused of fraud. But while such is the case, retraction has been made, and we do not see how the libel suit brought by the Exposition Company can do any further good. Every journalist is liable to make mistakes, and when he apologizes promptly, that ought to be enough, unless there is proof of actual injury to reputation and purse.

We are not surprised that there have been doubters as to the actual delivery of energy from Niagara, but we are surprised that a thing so readily susceptible of proof should be attacked without any sort of rational investigation. Moreover, the standing of the companies and individuals interested ought to have been enough for their protection from such an imputation, involving incredible baseness on the part of every one concerned.

The transmission would, of course, have been vastly more important if it had taken place on regular power wires with power in large bulk. But such conditions were not obtainable, while the Western Union wires were. It is at least highly creditable to the ability of the designers of the Westinghouse Company that they produced right off, with only the change from a smooth to a grooved pulley, the apparatus to receive the power coming from Niagara. Some day the engineers will probably give us all the figures. Meantime, whether they deliver 50 watts or only 5, they have, as Mr. Stillwell modestly claims, done what they started out to do—made their motor run at the end of a 465-mile circuit. We understand that several interesting and novel conditions have been observed in the little experiment during the month.

AIR MOTORS FOR NEW YORK STREET CARS.

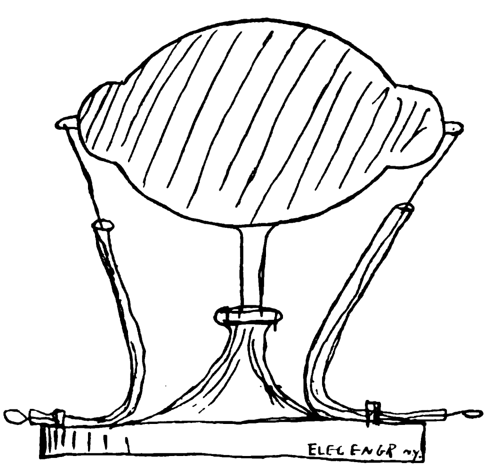
THAT the Metropolitan Traction Company should not be enamored of the underground trolley system put in for it on trial by the General Electric Company is not surprising, for as we have already intimated, from time to time, it has been found pretty expensive and troublesome to run the road. But it is surprising to find the company harking away after air motors for their cars. That is one of the old buzz saws that so many fingers have been clipped by, and now a new generation of engineers and capitalists is in line for ultimate painful amputation. It would have been better to stick to the G. E. underground system, imperfect as it may still be.

News and Notes.

THE EDISON FLUORESCING VACUUM LAMP.

CONSIDERABLE interest has been aroused during the past week by the announcement that Mr. Edison had devised a new type of vacuum lamp which he intended to show at the Electrical Exposition during the week. The exact nature of this lamp was described by Mr. Edison himself in The Electrical Engineer of April 15 and we need therefore only repeat Mr. Edison's own words to recall the matter to our readers:

"A vaccum tube, the inner portion of which has fused to it crystals of tungstate of calcium when exhausted to the X-ray stage, gives out scarcely any of the rays; on the other hand,



The Edison Fluorescing Vacuum Lamp.
(*From a sketch made by Mr. Edison.*)

the tubes shine with a splendid white fluorescence. We have here a true fluorescent lamp, possibly commercial, as a very small bulk gave in the photometer 2½ candle-power with an extremely small amount of energy. The white light is of a character not unpleasant, but quite the contrary. The spectroscope reveals the reason; the spectrum has strong red rays."

We understand that Mr. Edison has succeeded in largely increasing the efficiency of his new type of vacuum lamp. The latest form of the lamp, shown in the accompanying engraving, resembles very closely the X-ray tube adopted by Mr. Edison with the electrodes at opposite ends, but with a slightly greater diameter at the center.

A CUSTOMS DECISION ON LAMP SHADES.

The following decision has been handed down by the Board of United States General Appraisers: P. H. Petry & Co. vs. Collector at New York.—Covers for electric lights made of glass beads strung on wire. The claim that the same are dutiable at 10 per cent. under paragraph 99 was overruled, and the assessment at 35 per cent. under paragraph 102 was affirmed.

AN ELECTRIC LAUNCH, 36 feet long, has been put on the lake at Prospect Park, Brooklyn. It makes the round in 23 minutes under half headway.

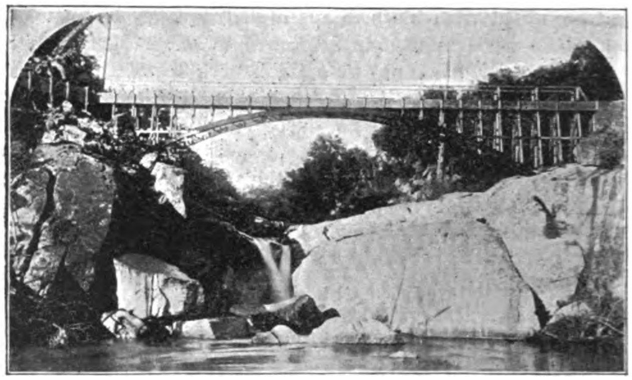
Power Transmission.

TRYING VOLTAGE EXPERIMENTS AT TELLURIDE.

The Westinghouse Company, in connection with the Telluride Power Transmission Company, of which L. L. Nunn is general manager, is carrying on some experiments in power transmission at high voltage. Mr. Nunn has been supplied with converters amounting in all to about 200 horse-power capacity, and suitable for transforming from 3,000 to any desired higher voltage up to 60,000 volts, and these converters are used as raising and lowering transformers in transmitting about 100 horse-power over an ordinary iron telephone wire a distance of about two and a half miles to operate a stamp mill, the iron wire constituting the line costing only $35. When Mr. Nunn first proposed this transmission of two and a half miles some years ago, using direct current transmission, the estimate made for copper was in the neighborhood of $65,000. This transmission plant has been run at various voltages from 15,000 to 60,000 volts inclusive, and during snowy weather at about 35,000 volts.

THE 35-MILE THREE-PHASE TRANSMISSION AT FRESNO, CAL.

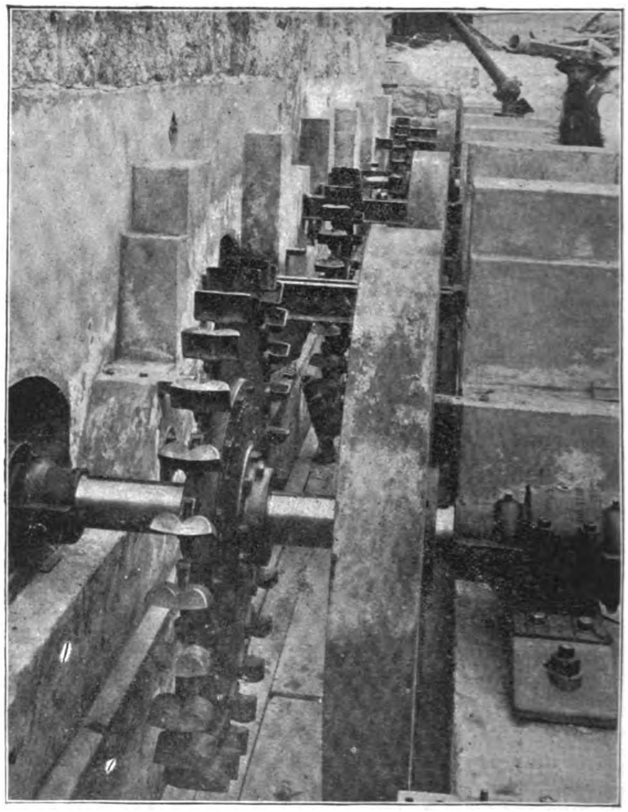
THE work on the three-phase electrical plant at Fresno, Cal., which has been carried on for the past year, is rapidly drawing to completion. This transmission will be the longest and most unique in many ways ever effected commercially, and will result in endowing Fresno and the surrounding towns and villages with a system of light and supply of cheap



Flume Bridge, Fresno Transmission Plant.

power equal to that of any Eastern city situated in proximity to a coal center.

The power house is located on the north fork of the San Joaquin River in Madera County, about thirty-five miles northeast of Fresno, at the foot of a steep hill and facing another equally as steep. The point of diversion lies some miles



Pelton Wheels, Fresno Transmission Plant.

away where the north fork runs through a narrow cañon with solid rock walls. A flume and ditch with a total length of seven miles have been built and excavated on the easy sidehill slopes and the right of way has been cleared of all trees and obstructions for a width of 150 feet. The grade of the canal and flume is 5.28 feet to the mile. The lower bank of

the canal is sufficiently wide to serve as a wagon road for the inspection teams. The minimum low water flow of the stream at the point of diversion is 50 cubic feet per second, which will develop, at the head available, over 7,000 horse-power at the water wheels.

The reservoir is situated at the top of a high hill, the river being some 1,600 feet below. The pipe line leading from the pressure box in the reservoir is 4,100 feet long, and in this distance the vertical difference in level is not less than 1,400 feet—one of the highest heads of water ever used for power purposes. For the first 400 feet the pipe is of riveted steel, and for the balance of the distance is lap welded, with lock joints, five-eighths of an inch thick at the lower end with a diameter of 22 inches.

At the power house the pipe enters a receiver of three-quarter inch steel, 57 feet long and 30 inches in diameter. The joints are of the butt strap type, and the receiver is designed to stand a working pressure of 300 pounds per square inch.

The power house, of native granite, is 75 feet long and 30 feet wide, with a wooden roof. The water wheels are outside the main power house, the shafts passing through the heavy granite wall, which effectually keeps all water and moisture out of the dynamo room. The three wheels are of Pelton make, 57 inches in diameter, each capable of developing 500 horse-power at 600 revolutions per minute under an effective head of 1,410 feet. They have steel plate centers and bronze buckets and are fitted with flywheels five feet in diamter. Separate wheels are provided for the exciters.

The electrical installation is not yet completed. It will consist of three General Electric three-phase generators each of 350 kilowatts capacity, directly connected to the water wheel shafts. The current will be raised in transformers to 12,000 volts and will be caried on poles for 34.4 miles to the substation at Fresno. It will then be transformed down to 200, 1,000 and 3,000 volts, the first for the low tension supply in the business portion of the city; the second for the three-phase supply in the residence districts; the third for the three-phase supply to the vineyards and wineries within a radius of ten miles from the sub-station.

Contiguous to the station is the pump house of the Fresno Water Company, in which the pumps are already operated by a 75 horse-power, three-phase induction motor. This is the first motor operated by the transmitted current. The work is being rapidly pushed forward and within a few weeks it will be finished, and another great step in the electrical transmission field will have been made.

MISCELLANEOUS.

THE HAYDEN CENTURY CLOCK.

BY M. H. LOCKWOOD.

MR. J. F. HAYDEN, class of '96, Trinity College, Durham, N. C., has designed and constructed a novel clock which may now be seen running in the Physical Laboratory.

The clock is run entirely by electromagnets which are actuated by the current from an earth battery.

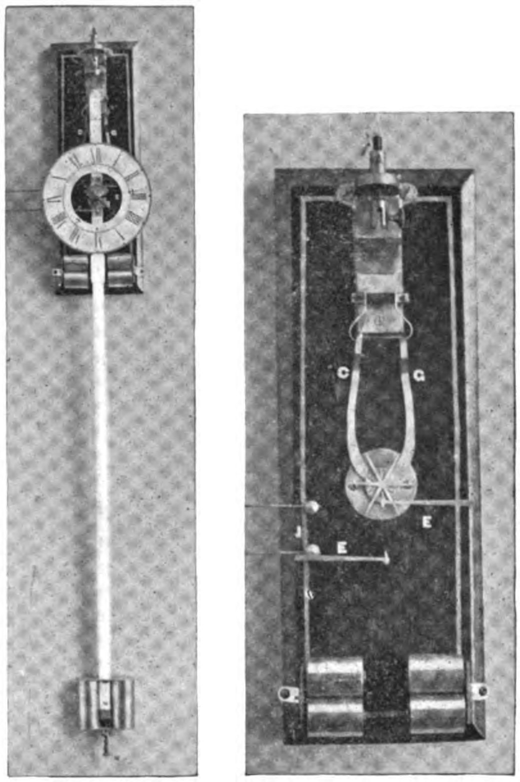
The pendulum is constructed after the usual pattern, with wooden shaft and heavy cylindrical weights for the bob, and is suspended from the bracket attached to the back-boards, as seen in Figs. 1 and 2. It is the pendulum that runs the clock.

By means of the automatic switch, C G, the current from the battery is sent around first one and then the other of the electromagnets D and H. The screw, A, at the upper end of the pendulum is electrically connected to the upper binding post, J, and also to two contact points, one on each side of the shaft at L. The arms, C and G, of the automatic switch are insulated from each other. The upper arm, G, is in metallic connection, through the central screw, with a wire in the rear of the back-boards, leading to the coils about the pair of magnets, H. The lower arm, C, rests on the brass plate, F, the latter being connected with the coils about the magnets, D.

As the pendulum swings, it is readily seen that the current will alternately pass around the two pairs of electromagnets, D and H, and the two soft-iron armatures at I will be alternately attracted.

The working of the clock can best be understood by following the current through a complete cycle. Starting from the upper of the binding posts, J, the current passes to A, then through the piece of sheet steel, B, attached to the upper end of the pendulum shaft, to the contact points, L. When the pendulum starts from the magnets H towards the magnets D, the contact is made from L through C, and the current will pass around magnets D, and from there to the lower binding post, completing the circuit through the battery. It will be seen that this aids the force of gravity in carrying the pendulum towards D. When the pendulum starts back from D, the contact is made with G, and the current passes around the magnets H, giving the pendulum a pull in that direction. If these pulls at each stroke of the pendulum are sufficient to overcome the loss by friction of the moving parts, it will continue to vibrate.

To regulate the amount of current passing to the electromagnets, two brass tips are affixed to the shaft at K, their distance apart being readily adjusted by screws. Shortly after the contact is made with C, as the pendulum swings toward D, the connection is broken by the arm, C, coming in contact with the strip, K, on that side, and if the current is very strong the strip will push the switch far enough to throw G into contact, and the current will pass around the magnets H. The latter acting will tend to retard the motion of the pendulum toward D. By adjusting the distance between these strips, almost any current may be used to run the clock.



THE HAYDEN CENTURY CLOCK.

As a novelty in the construction, the works and dial are placed upon the pendulum and swing with it. The seconds hand is attached to a ratchet wheel having sixty teeth, and is actuated at each stroke of the pendulum by the pawls, E E, which are attached to the back-board. The motion is communicated to the minute and hour hands by the usual intermediate wheels. The movement is jeweled and the pawls have steel tips. The tips of the pawls work in semicircular grooves in such a manner as to make it impossible for them to catch more than one tooth at each stroke of the pendulum. The length of pendulum is adjustable both at the upper and at the lower end by means of suitable screws.

The lower end of the pendulum is provided with two needle points fixed in the nut, n. These pass simultaneously through two drops of mercury, each of which is in metallic connection with one of the binding posts at the right hand lower side of the case. Thus we have a clock that may be used in many laboratory experiments where a seconds pendulum is required. A local circuit will be closed through an electric bell or telegraph sounder at each stroke of the pendulum. All the electrical contact points in the clock are of platinum, and the working parts of the switch are adjustable for wear.

The earth battery is built in the ground near the building and consists of several old boiler grate bars as one electrode and several bushels of coke as the other. The battery will last for an indefinite period and should run the clock for 50 or 100 years.

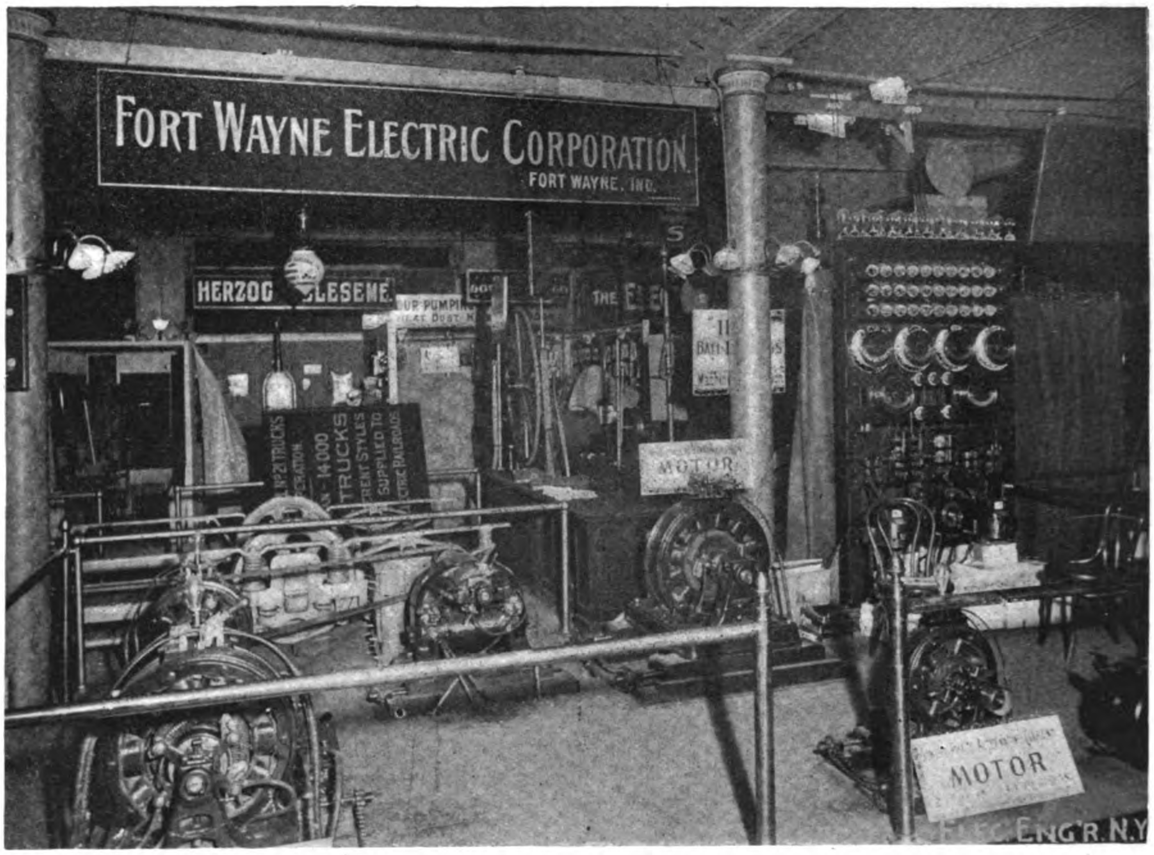


EXHIBIT OF THE FORT WAYNE ELECTRIC CORPORATION.

THE "ELECTRA" CARBON EXHIBIT OF HUGO REISINGER.

EXHIBITION NOTES—III.

PAGES FROM OUR EXPOSITION ALBUM.

LAST week we presented a number of views of leading exhibits at the National Electrical Exposition accompanied by notes upon them as well as upon many of the other exhibits of which our photographer had not, in spite of steady, hard work, succeeded in securing pictures at the time of our going to press. This week we are able to supplement our notes with a large number of fine views of exhibits previously described, but not hitherto illustrated. They will serve to give an excellent idea of the generally high quality of the exhibits and of the admirable decorative effects aimed at. It is said that no snow has ever been given in New York at which the effect or tout ensemble was better. This is the more striking when it is remembered that a large majority of exhibits embrace machinery of the most prosaic and practical character. Still, electricity is clean, neat and handy, and for this reason alone, if for no other, encourages the practitioner on such occasions to try his hand at decorative effects.

MARCUS NATHAN.

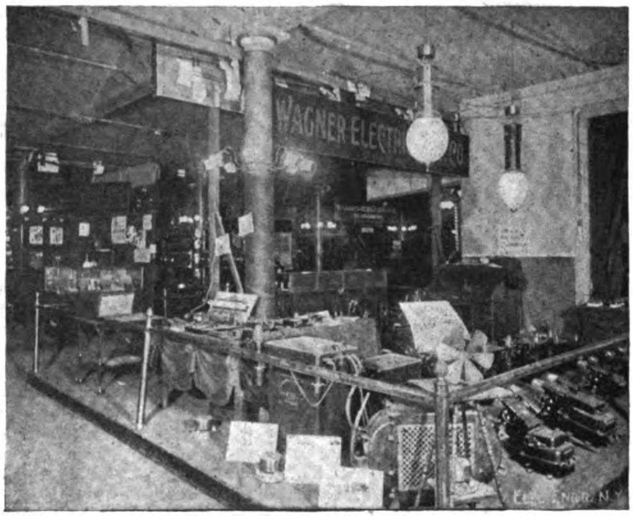
We give herewith the portrait of Mr. Marcus Nathan, the superintendent of the National Electrical Exposition, to whose valuable services we made incidental reference last week. Mr. Nathan is only thirty-one years of age, but is ripe with a long business experience. His earlier training lay in the dry goods field, and as manager of the house of Bloomingdale Bros. he made a high reputation for executive ability. He has now been connected with the Grand Central Palace for two years, in various ways. He has always had a taste for construction

SUPT. MARCUS NATHAN, OF NATIONAL ELECTRICAL EXPOSITION.

work, and for several years past has been engaged in electrical and machinery contracting work for the export trade to Cuba and Mexico. To this familiarity is due the ease with which he has grappled with many of the serious problems of wiring and lighting at the exposition. His work in general there has had all the qualities that go to make such a great enterprise a brilliant success.

THE EXHIBIT OF THE WAGNER MFG. CO.

WE have already referred to this company's exhibit, and now take much pleasure in illustrating it. Aside from the high excellence of the goods shown, the company deserve warm praise for their enterprise in thus making so bold a bid for Eastern patronage, a good many miles from their St. Louis home. But no one who has inspected the apparatus can



THE WAGNER ELECTRIC CO.'S EXHIBIT.

remain in doubt as to its ability to make friends and customers everywhere.

The exhibit of the company includes the most complete line of transformers in the building. The types and styles of these have already been illustrated in our pages, and the collection includes a large transformer for high potential long distance work. There are also arc lamps to show the application of the Wagner "Economy Coils," and a fine display of alternating and direct current fan motors of the well known and popular Wagner make. In addition to all this, there is shown a fine line of switches and tablet boards, in which the workmanship and ingenuity of design are admirable.

DE VEAU & CO.'S EXHIBIT.

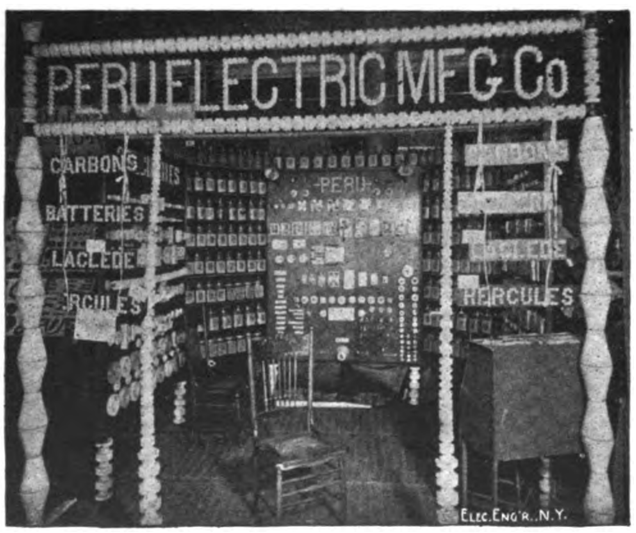
SITUATED directly to the left of the main hall entrance of the exposition is the exhibit of Messrs. De Veau & Company, of New York. The heart of the telephonist is delighted by the variety of types of telephone instruments, receivers, transmitters, etc., which are shown mounted on the wall and exposed in the show case, as illustrated in our engraving

DEVEAU & CO.'S EXHIBIT.

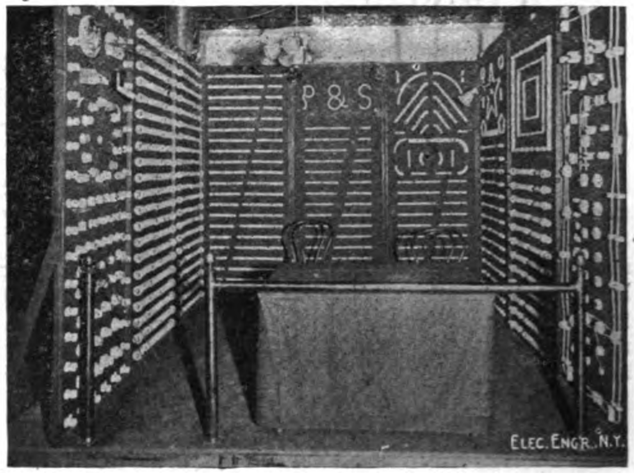
representing the exhibit. The variety of transmitters for short and long distance work is specially noteworthy, showing that the company have provided for every contingency in the telephonic field. The telephone, switchboard and magneto bell out-

THE JOHN A. ROEBLING'S SONS CO.

THE BISHOP GUTTA PERCHA CO.

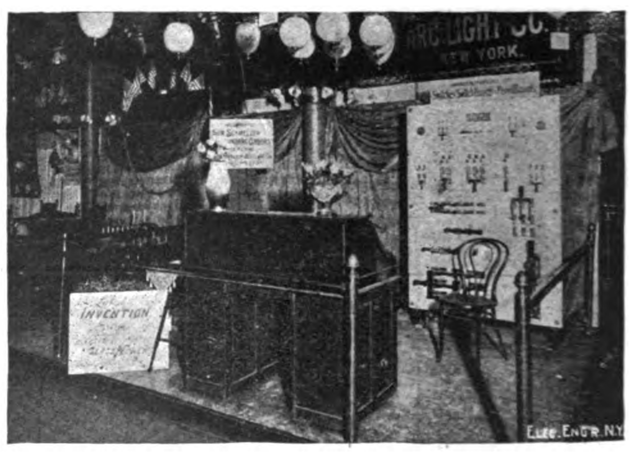


THE PERU ELECTRIC MANUFACTURING CO.



PASS & SEYMOUR.

THE JOS. DIXON CRUCIBLE CO.



THE INCANDESCENT ARC LIGHT CO.

fits on exhibition show that the company are fully prepared to handle interior as well as exchange systems.

THE CURTIS-HULL AUTOMATIC ELECTRO FEED WATER PURIFIER AT THE EXPOSITION.

The Automatic Electro Feed Water Purifier, as shown by the cut, and its action, with personal explanations given by three of the Curtis-Hull Manufacturing Company's representatives at the Electrical Exposition in New York, space 257, ground floor, is creating much interest among the manufacturers, engineers, and others there in regard to preventing the formation of scale in steam boilers by galvanic action, produced automatically. The plates used in the purifier are specially prepared, according to the chemical analysis of the water used, and the heat of water must be 150 deg. or over, before passing through the purifier.

It is in no sense a filter, but by the electrical action that takes place, the affinity of the scaling ingredients for the iron, and also for each other, is destroyed, and the matter is deposited in the bottom of the boiler, like dust or otherwise, and then blown off.

If old scale has accumulated, and no new is allowed to form, it must dissolve and rot off from natural causes. A great saving is claimed in coal over all boiler purges, from the fact of its not allowing any scale to form. It also saves in cost of water rents when well water can be obtained. It also stops pitting and corrosion by using the ingredients that cause it for battery energy, and takes care of itself if attached and used as directed.

THE EXHIBIT OF THE GAMEWELL FIRE ALARM AND POLICE TELEGRAPH CO.

As noted in our columns last week, the above company, of New York City, have a very fine and extremely interesting exhibit at the National Electrical Exposition. It is also well handled and excellently described by the courteous attendants, who are constantly delivering terse, brief lectures to the large crowds that gather around the booth. Whenever a Gamewell box is opened on the aisle, a thick throng gathers at once; and here, where there is seen also the central apparatus for the fire house or police bureau, the fascinated public just stays around all the time. Such an exhibit must be regarded as a check on crime, for any one disposed to go and do wrong in the way of incendiarism and theft will certainly have deeply impressed on his mind the fact that detection and arrest are likely to come swiftly.

The space occupied is in Section J, 73-74, and is handsomely

THE GAMEWELL FIRE ALARM TELEGRAPH CO.'S EXHIBIT.

draped and fitted up. At each aisle corner of the exhibit, carrying a blue and gold banner, is a lamp post. One supports a Gamewell fire alarm box and the other a police signal box of the exact type used with such success in many large cities, and now so universal that in a little more than twenty-five years the company have equipped over 700 towns, cities, etc., with their fire and police telegraph systems. The boxes shown are connected in actual operation with a central station or exchange. At the wall on the back of the exhibit are grouped police boxes, the clock on the time stamp and dater for signals coming into central, the bank signal system, engine house indicator and gong, and different styles of fire boxes, keyless, etc. There is also the apparatus for the automatic Manhattan auxiliary alarm that throws a signal from any building where it is installed on the nearest fire box. Flanking this apparatus is the famous Gamewell automatic repeater for fire circuits, receiving on one and sending out over all the rest, and always placed as a central attraction in modern fire headquarters. On the other side is the big tower bell striker that is powerful enough to raise a whole town from slumber.

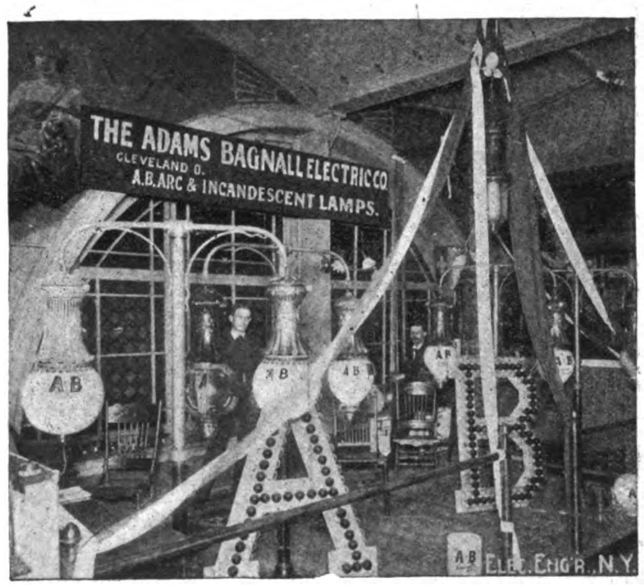
In the middle of the space against the back wall is a model and typical central office cabinet equipment with four circuits, each indicating for itself by a special drop, and having associated with it the dater and time stamp, as well as testing circuit, galvanometer, etc. It is a superb equipment and elicits much admiration. Here it is used more particularly to exemplify the instantaneous workings of the Gamewell police and bank signal systems as grouped around it on the back wall. The police box, for example, can send in seven signals by indicator alone, and then has the invaluable telephone service to fall back upon, each box having its receiver and transmitter. The bank signal box is equally efficient and easy to work, giving the maximum of instantaneous alarm and protection.

It is worth notice that the company build their apparatus with remarkable care and precision, and are now making their own time stamp for the cabinets, such stamps taking care of all chronological variations in the months and years. The woodwork is also beautifully finished. In regular work the company use a variety of batteries, including storage, dependent upon conditions. At the exhibit the apparatus is very successfully run by Gordon-Burnham cells.

This notice would not be complete without mention also of the fire alarm whistling machine, intended to act as a substitute or auxiliary for the gong. In short, ingenuity and enterprise are seen in every part of the exhibit, which is in charge of Messrs. A. L. Tinker and C. F. Waulen.

THE REMARKABLE EXHIBIT OF ADAMS-BAGNALL LAMPS.

The Adams-Bagnall Electric Company, of Cleveland, O., have one of the finest exhibits of arc lamps ever shown. They exhibit shunt and differential series arc lamps in various finishes, alternating, constant potential lamps for running two in series on 110 volt incandescent circuits, inclosed arc lamps which burn on incandescent circuits, from 100 to 150 hours from one pair of carbons, etc. A novelty in this type of lamp



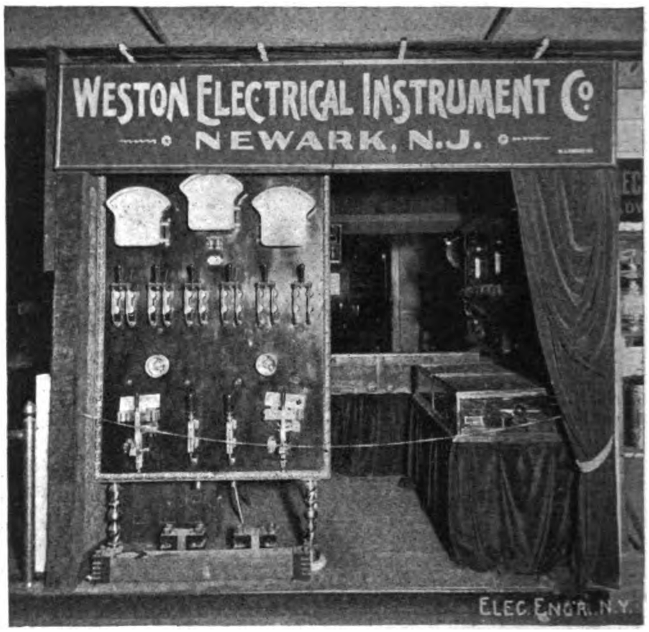
THE ADAMS BAGNALL ELECTRIC CO.'S EXHIBIT.

is called the marine lantern. It is designed for portable use on board ships. This lamp is provided with a bail, or handle, to enable a seaman to sling it on his arm and have free use of both hands in climbing masts to hang the lantern where desired for temporary use. A desirable feature of the inclosed arc is the entire absence of shadow. This, in fact, is one of the particular claims of the Adams-Bagnall Company on all of the

THE ELECTRICAL ENGINEER.

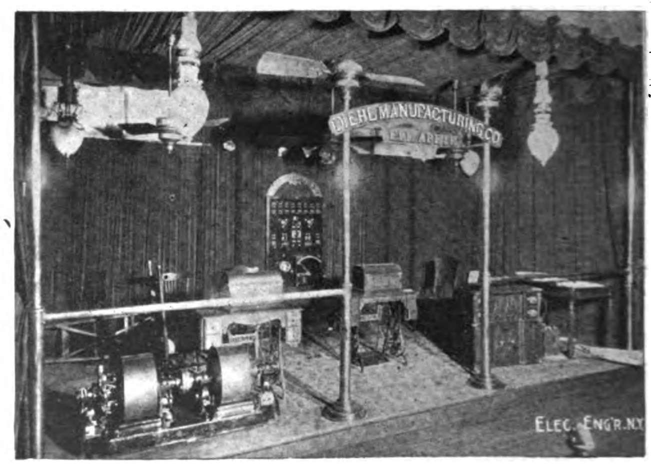
THE HOLTZER-CABOT ELECTRIC CO.

THE BIRDSALL ELECTRIC CO.



THE WESTON ELECTRICAL INSTRUMENT CO.

THE STANDARD PAINT CO. AND SCHIFF, JORDAN & CO.



THE DIEHL MANUFACTURING CO.

"A. B." arc lamps. The "A. B." lamp is a single carbon fourteen-hour lamp, focusing, and in which the globe is not removed for trimming, the carbons need no centering, and there are no rods to clean, no sliding contacts carrying current, and the lamp burns equally well with any current from four to fifteen amperes with no change in adjustment whatever. These lamps are changed from series to alternating or constant potential by simply changing spools, and the "A. B." railway lamp is changeable to constant potential or differential by changing connections only, thus making one type of lamp answer for three different circuits. There are many other features of value enumerated in their catalogue, to be had for the asking.

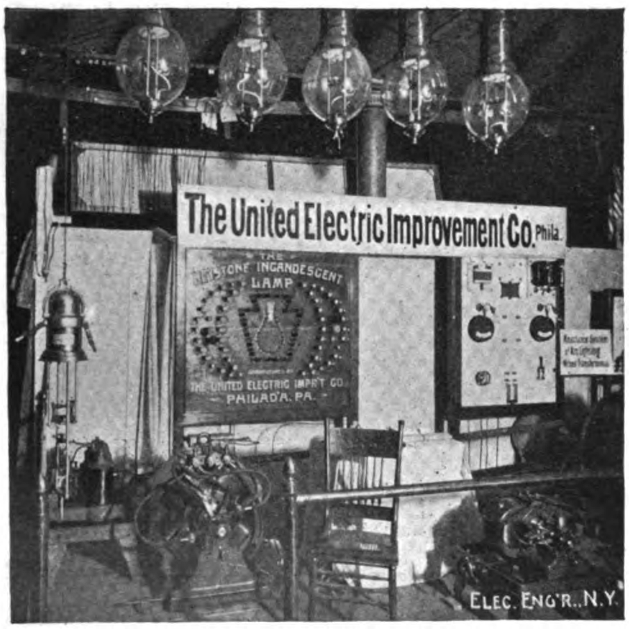
The "A. B.' incandescent lamp is also shown and attracts much favorable comment on account of the absence of the tip. It is getting to be one of the best and most favorably known incandescent lamps now in the market.

The exhibit is represented during the convention by Messrs. L. H. Rogers, E. J. Bagnall, A. B. Caldwell and A. D. Dorman. The New York office is located in the Havemeyer Building, in charge of A. D. Dorman.

The favor with which the "A. B." lamp is being received is evidenced by the large orders recently received, one of which is recorded in another column of this issue of The Electrical Engineer.

EXHIBIT OF THE UNITED ELECTRIC IMPROVEMENT CO.

THE exhibit of the United Electric Improvement Company is that of a complete plant and represents a modern installation suited for a small, scattered town. A small alternator of 40 kilowatts capacity is shown, which, at 840 revolutions per minute, will give 120 complete alternations. The main idea pervading the design of these alternators is that they shall be, above all, reliable and simple. Much of the business of the company is done with towns where plain mechanics are scarce and where good ones are not obtainable. The design of the alternator is suited exactly to these conditions. The armature is of the copper disc type—the only one manufactured



THE UNITED ELECTRIC IMPROVEMENT CO.'S EXHIBIT.

in America. The efficiency of these machines is second to none. The exciting current is somewhat higher than in machines having iron in the armature, but then there are no iron losses at all and this more than compensates for the 4 per cent. exciting current that is used in small machines. In the large machines the exciting current does not exceed 2½ per cent. of the total output. There is no heating in these machines to speak of and the output is limited only by the regulation, which is obtained without compounding.

Attention is also directed to the slow speed of these alternators. They are the only machines built the speed of which is inherently slow. The company has recently supplied a 150 kilowatt machine, directly connected to a Ball & Wood engine running at 300 r. p. m. The period of this particular machine was 100 and the exciting current was but 4½ per cent. at full load, and the inherent regulation 10 per cent. without compounding. The company does not think that this showing can be bettered anywhere. Mr. Horry, who is in charge of the exhibit, differs from some in their opinions recently advanced regarding the inductor alternator without collectors. In all of their experience, he says, the dispensing with the collectors in slow speed alternators is a purely imaginary advantage, not a practical one nor a real one. Of all the machines they have running, they have never in one instance known of the slightest hitch having ever occurred because of the collectors. The speed of their collector rings is always under 500 per minute, and with this speed the collector will outlive the attendant and will be found more reliable.

It is also the custom with many designers to ignore the iron losses that are found in alternators of the inductor type. These losses are serious enough in all alternators of the iron armature type, but they become much more so in the inductor machine with the iron stampings outside the rotary part. These losses are not so readily detected as the field losses, although they are far greater in amount and it would surprise many men to be told the true amount in horse-power that is wasted in the stamped iron of their alternators and that these losses are constant and unaffected by the load. Mr. Horry therefore regards it to the advantage of the machines of the United Electric Improvement Company that these iron losses are entirely absent.

The weight of the moving part of these machines is very small. In a 50 kilowatt machine it is only 200 pounds, not counting the shaft. This weight is so small and the speed so slow that the bearings, which are of bronze, give no trouble whatever.

These machines are built in sizes as follows: 40 kilowatts, speed 840; 50 kilowatts, speed 660; 60 kilowatts, speed 600; 75 kilowatts, speed 560; 150 kilowatts, speed 400; 200 kilowatts, speed 400; all of 120 cycles.

For direct connecting up to 200 kilowatts they run at 300 r. p. m., and give 120 volts at this speed.

The whole apparatus of the United Electric Improvement Company has been designed by Mr. W. S. Horry, who has been connected with the company for many years.

PROF. ELIHU THOMSON AT THE EXPOSITION.

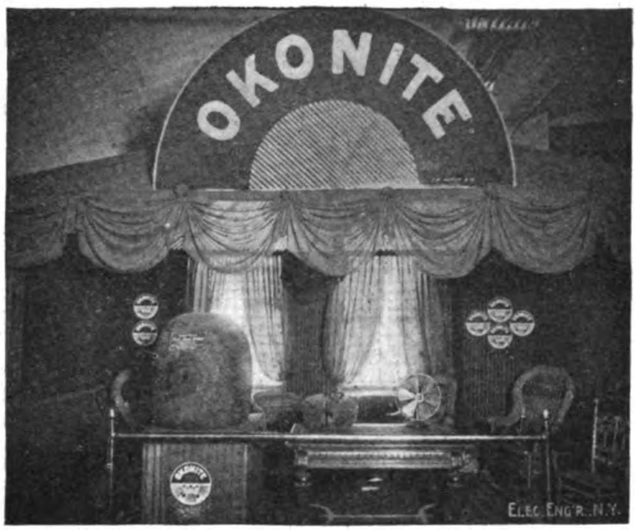
ALTHOUGH Professor Elihu Thomson, of Lynn, Mass., is prevented from attending the exposition by his unfortunate accident, he is represented by one of the most interesting and attractive exhibits at the exposition—his electrical models and alternating current repulsion apparatus. These occupy a corner of the annex.

Over fifty electrical models, representing Professor Thomson's inventions, are shown. Of special interest are a dynamo built in 1876; the first spherical arc machine, built in 1879; a self-starting alternating current single-phase motor; three early forms of the Thomson recording wattmeter, including the old oscillating type; the original lighting arrester, with magnetic blow-out; a ventilated transformer of 1886; a pair of transformers used in multiple in 1879; various devices for many point arc breaking switches; an original model inductor type dynamo of 1877; a dynamo with external and internal poles; a specially compounded electric motor for constant speed; a constant current transformer; an ampere balance built in the winter of 1881; an experimental alternating current rectifier; original variable reactive coil; the early type of iron-clad dynamo of 1885—a predecessor of the spherical incandescent machine; the first three-coil machine, wound by Professor Thomson in 1879; an experimental alternating current induction motor; eleven models of arc lamps, dating as far back as 1879, and including the old differential lamp, an early form of double carbon feed lamp and a lamp made in 1884, with independent action of shunt and series coils. The original welding transformer is shown with various samples of welding and photographs of the welding transformers and dynamos of the present time, and various commercial applications of electrical welding. Altogether it is a fascinating historical exhibit, showing the results of wide research.

Professor Thomson's alternating current repulsion apparatus, which has excited universal interest, is shown in operation every afternoon and evening. This apparatus, which illustrates some peculiar phenomena, characteristic of alternating currents, consists of two sausage-shaped magnets through which a heavy alternating current passes. The repulsive force, peculiar to alternating currents, is shown by various copper rings and flat plates, which, when brought forcibly toward the magnet, are repelled or are held supported in the air.

The inductive effect is illustrated by an incandescent lamp, which is connected to a coil of wire, and which burns brightly when placed over the end of the magnet. If a copper plate is put between the lamp and the coil, the lamp burns very dimly,

E. R. LATHAM & CO.

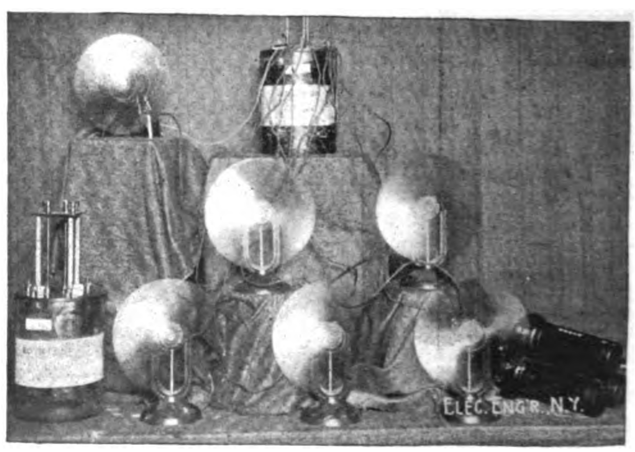


THE OKONITE CO.

THE CARPENTER ENAMEL RHEOSTAT CO., AND WARD LEONARD ELECTRIC CO.

THE HERZOG TELESEME EXHIBIT.

THE COLUMBIA INCANDESCENT LAMP CO.



THE BOYNTON MULTIVOLT BATTERY CO.

showing that only a small percentage of magnetic force passes through copper.

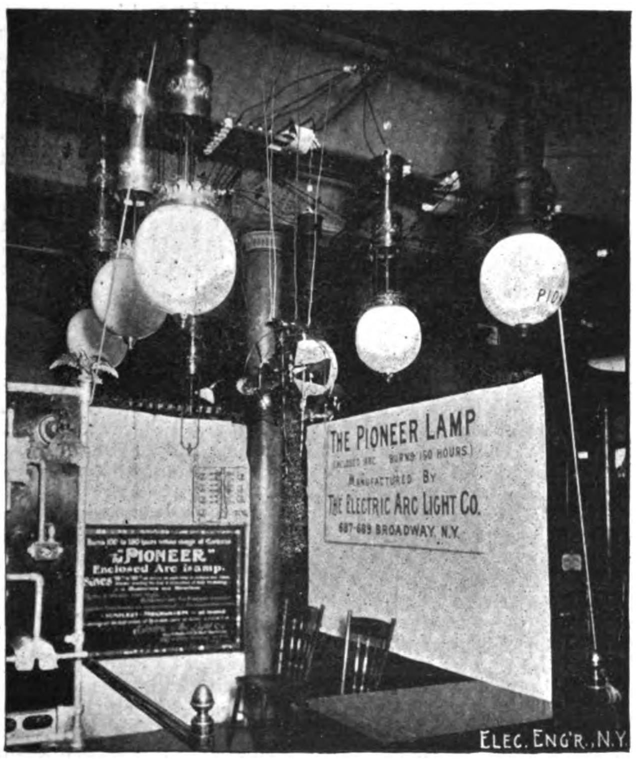
The floating lamp, burning under water, creates much surprise and comment. Various discs of copper and iron are used to show the rotary force due to alternating currents.

A great many visitors are attracted by these novel experiments. The results seem strange and startling, and interest deeply even the experts.

DR. PARK BENJAMIN'S RARE BOOKS AT THE EXPOSITION.

ALTHOUGH Dr. Park Benjamin has sent to the Electrical Exposition but a small part of his superb library of early and rare electrical books, which have served as references for his history of the intellectual rise in electricity, they fill several cases and evoke unbounded admiration. Dr. Benjamin has also greatly aided the student and visitor by grouping the books and by adding a series of useful explanatory and descriptive labels. The aim has been to open the books at some interesting page.

Probably the first printed work relating to electricity is that which appears in the 1490 edition of "The Lives of the Philosophers," by Diogenes Laertius, of which there is a unique copy in the collection. Then there is the mediæval cyclopædia of St. Isidore in the early edition of 1483, which tells all that was known of electricity up to the time of Columbus. In the same group ancient Chinese knowledge of the compass and of the use of that instrument upon land carriages is described in the first missionary translation of the Chinese classic "Shoo King." From the ancient authors one passes to the remarkable collection of original editions of the sixteenth century. In Baptista Porta's "Natural Magic" the first suggestion of the magnetic telegraph is made. In the books on "Subtlety," by Jerome Cardan, the attraction of the amber is for the first time fully differentiated from the attraction of the magnet; and, in the treatise of the Italian physician, Francastorio, the electricity of the diamond is first pointed out. There is also a copy of the letter of Peregrinus, originally written in 1269, and



THE ELECTRIC ARC LIGHT CO.'S EXHIBIT.

printed in 1558, suggesting the magnetic motor and the attraction and direction of a needle by a lodestone globe.

Then comes the actual beginning of modern electrical science. Here is the treatise of William Gilbert, written in 1600, on the magnet, wherein for the first time the word "electric" is used, and where electricity is for the first time recognized as a branch of science. Both the first and second editions of Gilbert's great treatise are exhibited, and the even more rare treatise which Gilbert left in manuscript at his death, and which was suppressed by Lord Bacon. Here, also, is a collection of little pamphlets by Ridley and Barlow, which mark the first electrical dispute. The idea of the telegraph becomes further advanced in the burlesque poems of the Jesuit Strada. It is repeated in the "Magnetic Philosophy" of Cabæus, in 1628, but that work is more remarkable because it adds to the science the first electrical discovery made subsequent to the work of William Gilbert—namely, that of electrical repulsion. Here also are the two great works of Galileo.

THE GORDON-BURNHAM BATTERY CO.'S EXHIBIT.

wherein he supports Gilbert and brings down upon himself the condemnation of the Church.

After Gilbert, Cabæus and Galileo came Paracelsus and other visionaries, who developed the notions now commonly known under the names of "animal magnetism," "hypnotism," etc. Here is a work on the magnet by Athanasius Kircher, general of the Jesuits, intended to break down the discoveries and theories of William Gilbert.

Then there are the curious books of Sir Kenelm Digby and Walter Charleton advocating what was then called the "magnetic cure of wounds."

The original edition of Charleton, published in 1650, is especially remarkable because here is used for the first time the word "electricity." Gilbert had used the word "electric" and Brown the word "electrical," but the word "electricity" had never been suggested until it appeared in Charleton's treatise.

Another book belonging to the progress of the science was the work of Descartes on "Deductive Philosophy," which had the effect of discouraging original physical research, but which, however, shows for the first time the complete magnetic spectrum.

The next advance in electrical progress is marked by the work of Otto von Guericke, which was issued in 1672. Here are described the first electrical machine ever made, electric light, electric sound, electric conduction, and electric polarity. Among the works of this group are the original English pamphlets of Robert Boyle on "The Mechanical Origin and Production of Electricity" and the works of Robert Hooke, issued in 1707, who was one of the most ingenious electrical inventors that ever lived and who suggested the phonograph. Here also are detailed the experiments of Hauksbee, who elicited and recognized the electric light produced in vacuum tubes and called the emanations from that electric light "rays."

Because of the discovery of the electric light produced from rubbed glass or amber, and because these sparks could be drawn from the fingers of electrified people, the Germans, in 1743, believed that fire existed in the human body and could be made to come out electrically. This notion created great excitement throughout Germany and set all the German philosophers hard at work upon electrical discovery. What they did is shown in another set of books.

The first book on electricity which ever came into the United States is shown here. It belonged to Benedict Arnold, the traitor, whose autograph is on the title page, and it possesses a further curious interest for all the visitors. It was a copy of this book that Benjamin Franklin studied, and his investigations culminated in his famous kite experiment and the proving of the identity of electricity and lightning. Franklin told the story of what he had done in a letter to the "Gentleman's Magazine," and the original clipping is shown in the collection. Here are also exhibited all of the original editions of Franklin's letters, in which he describes his various electrical dis-

coveries, and the French translation of them which first attracted to him the attention of European philosophers.

Of all the books of the collection none is probably so unique as that which begins the group of books which relate to the epoch of the "voltaic cell." This is the original pamphlet, written by Galvani, describing his frog experiments. But a very few copies—it is said only twelve—of this work were made, and these solely for Galvani's private use. The particular copy exhibited in Dr. Benjamin's collection not only belonged to him, but is the one on which he made the pen and ink corrections for the issue which was published during the following year. A copy of the 1792 edition, generally called the first edition, of Galvani's treatise, is exhibited in this group, and the corrections made by Galvani's own hand are duly noted.

Dr. Benjamin exhibits the first books which describe the secondary battery and the electric motor, and the exceedingly rare works in which the telegraph is first explained. A curious and most interesting relic is the original paper read by the famous French philosopher, Ampere, on the mutual action of two electric currents, which is the original document from which the author delivered his lecture, and which is annotated by himself. The first contributions to science of Michael Faraday and Joseph Henry are in the collection; so is Sir Humphry Davy's original paper on "The Safety Lamp," and there is a curious collection of early American books on electricity, dating back to 1802.

This intensely interesting collection is well set off by a group of autographs and portraits of early electrical worthies. It is not surprising to find scholars and experts bending over these cases for hours, but it gives one a new idea of the modern yearning for electrical information to see casual people studying the groups and labels, as well as the books, with rapt attention.

THE U. S. PATENT OFFICE EXHIBITS OF MODELS.

IT is difficult to find words of praise adequate to the interest, value and importance of the beautiful collection of 365 models sent by the U. S. Patent Office to the Electrical Exposition. The intrinsic value of the models alone would attract attention to them, for many of them must have cost large sums of money at the model makers'; but above all things looms the fact that here are represented the ideas and inventions upon which pretty well all the modern applications of electricity are based. The list in the official catalogue bristles with great names, and in every department one gets back to the beginnings and the fundamental ideas. Here are the first telegraphs, not omitting Bain and House and Wheatstone, or the special applications like those of Casselli, Farmer, Phelps, and others. Here are the early motors of Davenport, Jacobi, Page, Neff, Lillie, Griscom, and others. Here are the early magneto machines, not forgetting Pixii, in 1832; and here are exemplified the early dynamos of Edison, Weston, Brush, Thomson-Houston, Fuller, Hochhausen, Maxim, and the whole run of pioneers in that great field. As with the dynamos, so with the lamps and motors and systems of distribution—they are represented in these cases in profusion, and it is sometimes pathetic to note how much of spirited and talented endeavor has been absolutely thrown away in work whose outcome was failure.

There are in the collection a good many telephonic models, including some of Prof. Bell's earliest, but not forgetting those of Phelps, Edison, Dolbear, Gray, Gilliland, Brown, Eccard, and others. Even Mr. G. Westinghouse, Jr., appears to have had telephonic ambitions in his salad days, if these records in model form may be believed.

Many of the patent models shown are curious, such as one for electric whaling and another for electric weighing, or a funny one for painting telegraph wires, dated 1849. As an offset to these are the fine specimens of electric welding of Prof. Elihu Thomson, remarkably illustrative of a distinctly new art. And while mentioning this name, it is odd to see, as far back as 1879, a scheme of Thomson and Houston for the storage of electricity.

THE FISKE RANGE FINDER AT THE EXPOSITION.

One of the recent and most attractive features of the Historical and Loan Exhibit of the Electrical Exposition is the set of electric range finding apparatus designed by Lieut. Bradley A. Fiske, U. S. N., and to be placed on the big new battleship "Iowa." It is intended to measure with exactitude the range or distance of the enemy.

Two telescopes, at the ends of the ship, are fitted with contacts, which move along arcs of resistance wire, as the telescopes are directed at any object. The wires are connected together as a Wheatstone bridge, the galvanometer of which is placed in a secure place below the water line of the ship. The act of directing the telescopes towards any object disturbs the "balance of the bridge," and makes the galvanometer needle deflect by an amount proportional to the convergence of the telescopes, and inversely proportional to the distance. The scale of the galvanometer is divided into yards, so that the needle automatically points to the graduation representing the distance of the object. The operation of the device is perfect, and the simple ingenuity of the scheme pleases every electrician.

HOW THE POSTAL-COMMERCIAL MESSAGE WENT.

WE are indebted to Mr. Francis W. Jones, electrician of the Postal-Telegraph Cable Company, for the subjoined very interesting itinerary of the message sent from the Exposition Building to Tokio, Japan, and back, over the Postal wires, Commercial cables, etc.:

New York via Meadville, Pa., Chicago, Kansas City, Albuquerque, Los Angeles, to San Francisco; distance, 4,118 miles.

San Francisco via Vancouver, Winnipeg, Montreal, to Canso; distance, 4,914 miles.

Canso to London via Commercial cables and Waterville, Ireland, 2,823 miles; London to New York, 3,663 miles; total, 6,486 miles.

Grand total of message covered in four minutes, 15,518 miles.

The message from New York to Tokio, Japan, traveled as follows:

	Miles.
New York to San Francisco	4,118
San Francisco to Canso	4,914
Canso to London	2,823
London to Tokio	13,677
Tokio to London	13,677
London to New York	3,663
Grand total	42,872

OHM'S LAW AT THE SHOW.

"A Reminder of Ohm's Law," distributed by the progressive Standard Underground Cable Company, is the title of one of the novel souvenirs at the exposition, and one the most sought for by electrical people. It impresses on the mind of every one who sees it the essential primary laws of the science. It can be secured at the company's exhibit or by writing or calling at the nearest office of the company. Samples of their standard makes of lead-covered cables, the catalogue and descriptive lists attract considerable attention and are in great demand. The company is well represented by Manager G. L. Wiley, A. B. Saurman and Edward Sullivan, of New York. Mr. J. W. Marsh, the general manager of the company, has also been in attendance.

THE "ELECTROTHERM" AT THE SHOW

One of the electrical devices in operation in the exhibit of the Edison Electrical Illuminating Company at the Electrical Exhibition, is an asbestos heating pad, about a foot square, called by the makers an "electrotherm," which promises to soon become of great usefulness in all households, hospitals and sanitariums served with an electric current. The pad consists of asbestos with fine resistance wires woven into it, which become heated as the current passes through them. When uncovered the pad looks very much like, and is as soft and flexible, as a piece of asbestos cloth, but when connected to the electrical circuit by means of any lamp socket the increasing warmth gives early evidence of hidden influence. It soon becomes apparent that this pad, with its uniform and continued temperature, which may easily be regulated by turning a simple switch, is well adapted to displace the heretofore troublesome water bottles and compresses with their decreasing and violently fluctuating temperatures, and so add materially to the comfort and health of the invalid, while at the same time safely diminishing the care and responsibility of the nurse. The electrotherm should prove most valuable in cases of sickness, such as rheumatism, cramps, diphtheria, pneumonia, severe colds, cold feet and numerous other ailments which sooner or later become a part of everybody's experience, and which have heretofore been inadequately treated with the inconvenient water bottle or plaster; and, especially in severe or serious cases, where a prolonged and even temperature may be desired or positively necessary. The electrotherm is light in weight and cleanly, and requires no preparation other than attaching to an electrical fixture the flexible cord furnished for the purpose. It is made in several forms, one of which has a neat cane cover, and is designed as a

foot warmer and for warming beds or dishes. There are many instances where the electrotherm has proven its great convenience and efficacy in affording relief to invalids or those temporarily injured, and it may readily be imagined that in the not very distant future it will be the electrically-heated pad which will have an indispensible place in the household instead of the old-fashioned, clumsy and inelegant water bag.

LIBEL SUIT BROUGHT BY THE EXPOSITION CO.—THE NIAGARA TRANSMISSION.

THE National Electrical Exposition Company, through their counsel, J. G. Wells, 10 East Fourteenth street, brought suit last week in the Supreme Court against the W. J. Johnston Company, publishers of the "Electric Railway Gazette" and the "Electrical World," for $50,000 damages for libel, the suit being based upon an article in the last issue of the first-named paper, charging that the exhibition of Niagara power transmission at the Electric Show was in the nature of a "fake" and a "gigantic fraud" upon the public.

The officers of the National Electrical Exposition Company

THE CALCULAGRAPH EXHIBIT AT THE NATIONAL ELECTRICAL EXPOSITION.

are: H. J. Smith, general superintendent of the Edison Illuminating Company, of New York; W. F. Weiss, vice-president of the New York Steam Heating Company; George F. Porter, secretary of the National Electric Light Association; C. O. Baker, Jr., of the Baker Platinum Refining Company; R. B. Corey, General Incandescent Arc Light Company; H. L. Lufkin, Crocker-Wheeler Electric Company, and E. F. Peck, of the Peck Electric Company.

Mr. Johnston, upon learning of the publication in his paper, immediately made the following apology and retraction:

"In the 'Electric Railway Gazette" of May 10 appeared an item, written immediately after the opening of the Electrical Exposition, saying that the success of the experiment in the transmission of electric power from Niagara to New York savors strongly of 'fake.' The author of the paragraph believed at the time that he had grounds for making the assertion. He has since made a thorough examination of the circumstances, however, and satisfied himself that he was entirely mistaken in what he said, and a correction will be made in the next issue of the 'Gazette,' dated May 25. I need not add that both the author of the item and I regret the appearance in an electrical journal of anything that might be construed as a reflection upon the good faith of the well-known companies and gentlemen to whose efforts are due the success of the Niagara transmission. (Signed) W. J. Johston, Editor, 'Electric Railway Gazette.' "

Mr. L. B. Stillwell, electrical engineer, of the Westinghouse Electric & Manufacturing Company, also signed a statement as follows: "The power used to operate the small Tesla motor at the Electrical Exposition comes from Niagara. During the evening it is transmitted over a circuit consisting of three conductors. Two of these are wires ordinarily used for telegraphic purposes by the Western Union Telegraph Company. The third is the earth. In technical language, it is a case of tri-phase alternating current transmission. For a time direct or continuous current was used.

"When the alternating current is in use the potential as measured across any two conductors at the Niagara end of the line is approximately five hundred (500) volts. The currents are delivered to the Exposition Building at a potential approximating two hundred and fifty (250) volts.

"The gentlemen in charge of this undertaking have accomplished precisely what they undertook to accomplish and the transmission is an unqualified success. (Signed) L. B. Stillwell."

Mr. T. C. Martin was also asked for a statement, which is here appended: "For nearly a year past I had believed it possible to deliver Niagara energy over wire, at the exposition, and some months ago set out to do it, by securing a small model of the Niagara power plant, to begin with; then permission from the Niagara Falls Power Company to connect with the power house; Tesla apparatus from the Westinghouse Electric & Manufacturing Company for the transmission to the model; two wires from the Western Union Telegraph Company; and wires from the American Telegraph and Telephone Company (long distance telephone) to transmit the roar also to the model. The plan has been, to my positive knowledge, carried out, as I have personally watched the accomplishment of my plan. The electrical engineers co-operating have been Mr. A. S. Brown, of the Western Union Company; Mr. Nikola Tesla, Mr. L. B. Stillwell, of the Westinghouse Company, assisted by Messrs. Maclaren and Zimmerman, and F. A. Pickernell, of the Long Distance Telephone Company.

"I would add that as the Western Union wires are available only in the evening, I carried out the suggestion of Mr. A. S. Brown, of sending storage batteries to Niagara to be charged, so that the model could also be run in that way for the benefit of day-time visitors, who might otherwise be disappointed. This difference of method in day-time and at night has been carefully explained in labels and printed statements, so that there could be no doubt or misapprehension as to the facts.

"The Niagara transmission over Western Union wires has been a great success, doing far more than was expected. In fact, failure was freely predicted by many. (Signed) T. C. Martin, Editor The Electrical Engineer."

It should be mentioned that in reality three motors have been run from Niagara, namely, the Tesla, by alternating current, and a Lundell and a Crocker-Wheeler by the direct. The last were on during the trial tests just before the opening of the show.

"THE HOSPITAL WARD."

The Practical Electrical Laboratory at the exposition has been carried on with great success by Mr. Max Osterberg and his assistants, and is often more crowded than any other part of the exposition, especially when the rare phosphorescence of the diamond is shown in the Tiffany booth, or some experiments are being conducted with the beautiful Doremus apparatus. There is also a Röntgen X-ray exhibit, which has been in such frequent demand by visitors with inquiries, bullets in their bodies, etc., that the habitués of the exposition have dubbed it "The Hospital Ward." Hardly a day goes by when Mr. Osterberg or Mr. O'Connor is not requested by somebody to find out where that needle or bullet may be located. And every trial has been successful.

STORAGE BATTERIES AT THE SHOW.

THE extensive exhibit of the Electric Storage Battery Company at the exposition was added to last week by the installation of apparatus showing the formation of storage battery plates by the Planté process.

In a glass jar filled with electrolyte, two lead plates were immersed, the terminals being connected to a battery of chloride accumulators. Through a large magnifying glass placed in front of the jar, the action of the current on the lead was plainly discernible. It has proved an interesting feature to the crowds which watch it during the evening.

The electric launch in the company's exhibit has had a captain added to its equipment, in the person of a very small colored boy dressed in a "middy's" uniform of white duck, and with the words "Chloride Accumulator" on the front of his sailor hat.

The Chloride accumulators furnished the current to operate the telegraph instruments that started the messages around the world, and also for firing the guns that announced the departure and arrival of messages.

THE PERU ELEC. MFG. CO.

The exhibit of the Peru Electric Manufacturing Company, described in our last issue, is illustrated in the present number. The company not only make a beautiful and highly creditable display of their specialties, but are also advertising their porcelain in a decidedly novel way. Mr. Stevens, who represents the company, has favored us, among others, with a dainty inkstand, in the shape of an insulator made of Peru superior porcelain, capped with a removable slotted piece, and mounted in a nickel circlet supported by three handsomely turned binding posts, which serve as legs. The name of the company is stamped on the circlet. The inkstand is a useful souvenir as well as a good advertisement. It is needless to say that it is being much sought after and that the supply is necessarily far short of the demand.

Little three-year-old Helen Stevens is quite a drawing card at the company's booth, where she amuses herself nearly every evening with carbons, porcelains, binding posts, screws and screwdrivers, and other trade supplies, and attracts much attention by her prettiness and dexterity. She is known as the "Little Electric Girl," her only rival being the bright little chap, a year or two her senior, at the Birdsall Electric booth, who lights up his nose and mouth good-naturedly for the benefit of the passers-by.

THE W. J. HAMMER COLLECTION AT THE EXPOSITION.

We have already published details with regard to the fine exhibit made at the exposition in the Historical and Loan Department, by Mr. W. J. Hammer, and refer to it now only to say that that gentleman has supplemented his original display by many other things of equal interest and importance. The lamp and portrait collections are all that was expected, and daily attract large crowds.

Mr. Hammer has also added a handsome little case of historical wires, which have now been used both in connection with the opening of the show and the dispatch of the message around the world, the various sections having been electrically welded so that they would constitute continuous parts of the circuit. The wires are as follows:

1. Section of the wire over which Prof. Samuel F. B. Morse sent the first message by means of the Morse telegraph. 2. Section of the wire over which audible speech was for the first time transmitted by means of the Bell telephone by Prof. Alexander Graham Bell. 3. Section of the Atlantic cable through which the first cable message was sent across the ocean by Cyrus W. Field. 4. Edison plug and section of wire through which was lighted the first incandescent lamp ever lit from an electrical lighting central station. 5. Section of the first trolley circuit put up at the historic Richmond, Va., electric railroad by F. J. Sprague. 6. Section of the wire through which the current of electricity was sent by President Cleveland when he opened the World's Fair, at Chicago. 7. Section of the wire through which the electricity was sent to illuminate the headquarters of the American Institute of Electrical Engineers by Moore's system of vacuum tube lighting, this being the first room in the world so lighted. 8. Section of the cable through which the first current of electricity was transmitted from Niagara Falls electric power plant, April 16, 1895.

NOTES OF EXHIBITS.

THE STRAIGHT LINE ENGINE COMPANY are showing in space E 12 a 125 horse-power engine with a well-built General Electric 75 kilowatt generator.

THE WESTON ENGINE COMPANY, of Painted Post, N. Y., are operating a 90 horse-power engine at 280 revolutions per minute, belted to a Warren alternator. The engine runs at 280 revolutions and is in charge of Mr. John Harvey.

THE FUEL ECONOMIZER COMPANY have an exhibit which has proven particularly interesting to those engaged in central station work, as showing the economy which may be the portion of every central station manager by means of their device in connection with the boilers. The merits of the Fuel Economizer have been conscientiously portrayed to the visitors who have attended the exhibition.

THE KENNEDY VALVE MANUFACTURING COMPANY, of New York, show a line of their high pressure valves with by-pass, which stand 250 pounds to the square inch, valve posts with lock attachment, which are new and are shown for the first time, indicator valves, etc., all of which, as they say, are specially designed to meet the requirements of modern power plants. Mr. Hartenfels is in charge of the exhibit, and one of the features of the exposition is that several of the valves are used in the steam part.

W. F. BOSSERT, Utica, N. Y., has his exhibit in charge of his agents, C. C. Sibley & Company, 329 Fourth avenue, New York. It consists of a good sized line of junction, outlet, and switch boxes, showing one of the best methods of fireproof construction for iron and brass conduits. This display has attracted the attention of many engineers and contractors, the goods showing points of considerable merit. Messrs. C. C. Sibley & Company, aside from being the agents here for Mr. Bossert, have also the New York City sales agency for the General Electric Company.

THE DIAMOND ELECTRIC COMPANY, of Peoria, Ill., exhibit their specialty, alternating meters and transformers. Their display in the gallery of the exhibition is an interesting one, showing an assortment of meters and transformers from 10 to 300 lights capacity. Uncovered meters are shown in full operation, also transformers with the cases removed, showing the arrangement of coils and method of construction. Copies of tests of their different apparatuses are given away at the booth, which certainly speak volumes for the goods this firm manufacture. Mr. S. R. Sheldon has charge of their exhibit.

THE PENNSYLVANIA SLATE COMPANY, Cotton Exchange, have an attractive booth, showing samples of plain and marbleized slate. In order to be effective, slate for insulating purposes must be entirely free from any trace of metal, and in this respect the company claim their product to be preeminent, it being entirely free from the risk of short circuiting. Some very pretty specimens of marbleized slate are shown, it being extremely difficult to distinguish it from the genuine marble. The company solicit correspondence and will take pleasure in mailing descriptive matter and pamphlets on application.

TELMIC MANUFACTURING COMPANY, 52 New street, New York, with factory at Carteret, N. J., have a neat exhibit of their glazed firebrick clay conduits. This article they manufacture in various patterns, to be used in buildings as well as underground conduiting. A part of the wire from Niagara Falls to the exhibition building passes through conduits of this firm's make. The Telmic Manufacturing Com-

pany's product, although a comparatively new article on the market, shows decided merit and ought certainly to bring this firm a prosperous future. The exhibit is in charge of Mr. Walther H. Falconer.

THE AMERICAN STOKER COMPANY, of Dayton, Ohio, exhibit their boiler stoker. This is a gas machine pure and simple. The coal is carried back and forced upward at the same time by a tapered conveyor or screw. The green coals as they are forced up are coked by the incandescent coke bed above, the gases being released at this point, and as they pass up through the upper coke bed come in contact with the forced draft that is used in connection with the stoker, combustion then taking place. The combustion is so thorough that nothing but a clinker is left at the end of the day. The machine has been examined and commended by leading mechanical engineers.

A. A. GRIFFING IRON COMPANY, the most widely known and largest manufacturers of radiators and heating apparatus, are exhibiting the Baudy steam traps on the floor of the generating exhibit. This clever device is manufactured by them under the Littlefield patents, and is fast supplanting pumps for feeding boilers, for returning water of condensation to a boiler, no matter what pressure of steam is carried on the boiler. The A. A. Griffing Company, manufacture this specialty in conjunction with their other goods at their extensive plant in Jersey City, N. J. Their New York office, 66 to 68 Center street, will take pleasure in sending descriptive circulars and catalogues to any address upon application.

JOHN SIMMONS COMPANY, 106 Centre street, New York, the well-known wrought iron pipe concern, have an extensive display of their wares on the generating floor of the exhibition. Their exhibit comprises wrought iron pipe and fittings of standard and extra heavy weight; brass and iron cocks for high pressure work; tubular poles for railway and telegraph use, and a new feature, tubular framing for stone switchboards and partitions—an appliance of decided merit. This firm report doing a steadily increasing business in tubular iron poles for railway and telegraph use both in this country and abroad. The superiority of these poles shows itself in many ways. The cost is but a trifle higher than that of wooden poles.

THE GOULDS MANUFACTURING COMPANY, Seneca Falls, N. Y., with office at 16 Murray street, New York City, exhibit an interesting line of their celebrated triplex power pumps. Working models of their electric house pumps for tank service are shown in full operation. Photographs of some of their notable installations for waterworks and mine pumping cover the walls of the booth. The exhibit attracts the attention of a large number of visitors. Their electric mechanism is fast displacing the gas and hot air engine for pumping purposes as applied to private and business houses in large cities with inadequate water pressure. The "Goulds Efficient Power Pump" catalogue, an exhaustive work on their articles of manufacture, will be sent to any address on application.

THE AMERICAN WATCHMAN'S TIME DETECTOR COMPANY, J. S. Morse, treasurer, 234 and 235 Broadway, New York, exhibit their well known time detector, operated by battery and magnets, of which they have more than 8,000 in use all over the country. This firm takes pride in having it known that their watchman's clocks are used in nearly all the great electrical concerns, including the private laboratory of Mr. Edison, at Orange, N. J. They have also on exhibition a master clock driving the secondary clocks similar to the one in use in the Boston State House, where over 200 secondary clocks are in circuit. This is said to be the largest of its kind in this country. Three different kinds of employés' time recorders are also shown, and a new school programme clock, which rings simultaneously a varied programme in different rooms automatically for the assembling and dismissing of classes. This it does without resetting, for the entire school term. The exhibit is in charge of A. G. Morse, R. H. Smith and C. C. Bangs.

THE WILKINSON MANUFACTURING COMPANY, whose advertisement appears on another page, have their stokers in active operation at the exhibition. This stoker is certainly one of the best ever brought on the market and proves everything its inventor, Mr. Wilkinson, claims for it. The construction is so perfect, any interested person can readily recognize the saving of money in fuel, repairs to boilers and brick work. One of the greatest advantages claimed, however, is that it will burn low grade fuel with better economy than results from hand firing with high priced fuel. The Wilkinson Manufacturing Company, whose plant is at Bridgeport, Montgomery County, Pa., have a large force constantly busy turning out the numerous orders placed with them from some of the largest concerns in the country. The patronage of such users as the Philadelphia Traction Company, Pencoyd Iron Works, Baldwin Locomotive Works, and Pennsylvania R. R., speaks volumes for the stoker. Pamphlets and descriptive circulars will be sent to any address on application.

PERSONAL.

PROF. HAROLD B. SMITH, of Purdue University, has been elected to the new chair of electrical engineering recently established at the Worcester, Mass., Polytechnic. He is a graduate of Cornell, a young man, and highly spoken of. His term of duty will begin in July.

SOCIETY AND CLUB NOTES.

ANNUAL MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

THE annual meeting of the American Institute of Electrical Engineers was held at the National Electrical Exposition, by courtesy of the Exposition management, on May 19 and 20. There was a good attendance and brisk discussion throughout. The ticket elected is as follows: President, Louis Duncan; vice-presidents, Charles P. Steinmetz, Harris J. Ryan, Wilbur M. Stine; managers, John W. Lieb, Jr., F. A. Pickernell, William L. Puffer, L. B. Stillwell; secretary, Ralph W. Pope; treasurer, George A. Hamilton.

The hold-over vice-presidents are A. S. Hibbard, Dr. M. I. Pupin, and W. F. C. Hasson; and the hold-over managers are C. S. Bradley, W. B. Van Size, Carl Hering, and Dr. Cary T. Hutchinson.

ANNUAL REPORT OF COUNCIL OF THE A. I. E. E.

The annual report submitted by the Council covers the work of the Institute for the year ending April 30, 1896. The Council has held ten regular meetings and one special meeting. Prof. A. C. Perrine was appointed local secretary for the Pacific coast region, and on the resignation of Mr. B. J. Arnold, the office of local honorary secretary at Chicago was filled by Prof. W. M. Stine.

A Committee on Incorporation was appointed in December, and after a careful investigation of the subject the Institute was incorporated under the laws of the State of New York, on March 16, 1896.

The membership of the Institute shows a gain of 91 over the previous fiscal year and amounted to 1,035 on April 30, which is classified as follows: honorary members, 2; members, 333; associate members, 700. The treasurer's balance sheet for the fiscal year ending April 30, 1896, showed a balance on hand of $239.99. The building fund reported by the treasurer amounts, with accrued interest, to $939.48.

PLANS FOR THE NEXT AMERICAN STREET RAILWAY CONVENTION.

WE are in receipt of a letter and circular from the American Street Railway Association, as to its St. Louis convention, October 20, and four following days.

The building in which the association will hold its convention is the one erected by the Republican National Convention and is 260 x 180 feet. About eighty feet of the length of the building will be partitioned off for the sessions of the convention, leaving 180 feet square for exhibits, and all entrance to and egress from the convention will be through the exhibition hall. There will be no choice of space, every place on the floor being equally desirable. Exhibits of like character will be grouped together, and space will be assigned in the order of application. Wires carrying current will be brought into the building from street railway circuit, the voltage being 550, so that all mechanical devices may be operated. The income from sale of space will go to the American Street Railway Association. The executive committee of the association has fixed the price at 10 cents per square foot, and ruled that no space of less than 100 square feet will be assigned, but applicants may have as many multiples of this quantity as they may wish, all in one body. Payment for space should be made to Mr. T. C. Penington, secretary and treasurer of the American Street Railway Association, 2020 State street, Chicago, Ill., on or before October 1, 1896. Application for space should be made to Mr. George W. Baumhoff, chairman Com-

mittee on Exhibits, Park and Vandeventer avenues, St. Louis, Mo. Space must be applied for by August 15. "Assignments will be made as promptly as possible after that date, and exhibitors notified of their location." It is earnestly requested that all exhibits shall be in place and all work finished by Monday evening, October 19, which is the evening prior to the opening of the convention. Possession of the hall can be had on Friday, October 16, thus giving ample time for preparation. Watchmen will be in charge of the premises, so that exhibits will be safe.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS ISSUED MAY 5, 1896.

Alarms and Signals:—

INDICATOR FOR BOWLING ALLEYS. F. Becker, North Plainfield, N. J., 559,352. Filed April 24, 1895.
Means for throwing pin indicator when circuit is broken, said circuit being completed by metallic plate on bottom of pin resting on electrodes at suitable place in the alley.

INDICATING AND REGISTERING APPARATUS FOR METERS. P. Marix, Paris, France, 559,394. Filed Dec. 27, 1895.
A clockwork mechanism of a diagram chart in the form of a paper roll mounted on a horizontal arbor of said clockwork mechanism, a marker carried by a vibratory arm and bearing with light friction upon said roll, and means for shifting the arm.

ELECTRIC SIGNALING APPARATUS. T. G. Morse, Erie, Pa., 559,397. Filed Oct. 3, 1895.
For fire alarm purposes.

AUTOMATIC TIME RECORDING INSTRUMENT. H. F. Eaton, Quincy, Mass., 559,518. Filed March 20, 1893.
The recording sheet is moved only during the time a signal is being received.

ELECTRIC RAILWAY SIGNAL SYSTEM. L. J. Everest, Omaha, Neb., 559,576. Filed July 12, 1895.
Comprises a train of gearing actuated by a car wheel to permit a suspended terminal to drop, thus completing the circuit.

SWITCH AND SIGNAL MECHANISM FOR RAILROAD CROSSINGS. J. G. Schreuder, Wilkinsburg, Pa., 559,613. Filed March 31, 1893.
Mechanism for shifting the movable rails into line with the main rails and a lock operated by cars on the other line of track for holding the movable rails in derailing position.

BLOCK SIGNALING ON RAILWAYS. J. G. Dixon, Huddersfield, England, 559,688. Filed Nov. 25, 1895.
Consists in recording the number of wheels that pass out of a block section and the number of wheels that enter beyond the home signal of the next block station.

Conductors, Conduits and Insulators:—

CONDUIT FOR ELECTRIC LINES. J. Graizier, Geneva, Switzerland, 559,701. Filed Nov. 4, 1895.
The conductors rest on terra cotta cross-bearers and a layer of broken pieces of refractory insulating material is laid beneath and above the conductors.

Distribution:—

SYSTEM OF ELECTRICAL DISTRIBUTION. J. F. Kelly, Pittsfield, Mass., 559,530. Filed Nov. 20, 1895.
For alternating currents of different phase having an otherwise normally unbalanced mutual induction; a balancing transformer having its coils in series, respectively, with the mains carrying the currents of different phase.

SYSTEM OF ELECTRICAL DISTRIBUTION. B. G. Lamme, Pittsburg, Pa., 559,721. Filed April 11, 1895.
Means for changing the phase and wave form of alternating electric currents comprising two transformers, each of which is provided with two secondaries, those of one being respectively connected directly and reversely in series with those of the other.

Dynamos and Motors:—

ELECTRIC MOTOR AND MOTOR GENERATOR. L. Gutman, Chicago, Ill., 559,380. Filed July 10, 1894.
A self-starting synchronous motor, and a motor generator adapted to be supplied with a uniphase alternating current and to supply current to translating devices in a working circuit.

INDUCTOR DYNAMO. C. P. Steinmetz, Schenectady, N. Y., 559,419. Filed Feb. 15, 1896.
Inwardly projecting pole pieces provided with field magnet windings, armature coils mounted upon the polar faces, and a revolving inductor.

DYNAMO ELECTRIC MACHINE. J. F. Kelly, Pittsfield, Mass., 559,531. Filed Jan. 18, 1896.
An armature, consisting of two stationary laminated rings, having between them a magnetic bridge formed of bolts or bars.

PILLOW BLOCK FOR DYNAMO ELECTRIC MACHINES AND MEANS FOR SUPPORTING SAME. P. W. Power, Pittsfield, Mass., 559,538. Filed Feb. 19, 1896.
Two bars extending through the machine so as to have ends protruding from each end of the machine, in combination with a pillow block supported from said protruding ends.

DYNAMO ELECTRIC MACHINE. J. F. Kelly, C. C. Chesney and P. W. Power, Pittsfield, Mass., 559,584. Filed Jan. 22, 1896.
A revolving inductor having polar projections with a stationary armature, and energizing coil, and a stationary copper ring surrounding the revolving inductor.

ARMATURE FOR ELECTRIC MOTORS AND DYNAMOS. J. P. B. Fiske, Alliance, O., and H. A. Littlefield, Lynn, Mass., 559,692. Filed Dec. 14, 1894.
An armature core or drum having annular extensions at its ends, and a series of coils disposed on said core or drum and having their ends disposed on said annular extensions.

Electro-Metallurgy:—

APPARATUS FOR PRODUCING ZINC AND LEAD BY ELECTROLYSIS. R. O. Lorenz, Göttingen, Germany, 559,729. Filed Jan. 4, 1895.
Consists in converting the compounds containing zinc and lead into chlorids, which are subjected to an electrolytic process under the influence of heat.

Lamps and Appurtenances:—

ELECTRIC ARC LAMP. A. Jordan, Vienna, Austria-Hungary, 559,387. Filed Feb. 12, 1896.
Relates to feed mechanism for carbons.

ELECTRIC LIGHT ATTACHMENT FOR GAS FIXTURES. P. W. Remig, Brooklyn, N. Y., 559,403. Filed Jan. 25, 1895.
Details of construction.

ELECTRIC ARC LAMP. C. E. Scribner, Chicago, Ill., 559,407. Filed Dec. 30, 1893.
An automatic cut-out adapted to be brought into operation by any abnormal increase of the resistance of the main circuit through the lamp carbons.

ELECTRIC ARC LAMP. C. E. Scribner, Chicago, Ill., 559,408. Filed Jan. 9, 1894.
Similar to above.

ELECTRIC ARC LAMP. R. Segerdahl, Chicago, Ill., 559,412. Filed Sept. 10, 1895.
Employs a flexible carbon rod.

LAMP SOCKET. W. C. Wirt, Schenectady, N. Y., 559,474. Filed Feb. 8, 1896.
A key shaft formed with projections adjacent to its ends struck up from the key shaft and serving to retain the key shaft in its frame.

ELECTRIC ARC LAMP. M. Wheless, Washington, D. C., 559,648. Filed Dec. 7, 1895.
The combination of the feed yoke, the cap or dome, the counterweight track jointed to both the dome and the yoke, and the counterweight carried by and freely movable on said track.

ELECTRIC ARC LAMP. M. Wheless Washington, D. C., 559,649. Filed Jan. 29, 1896.
Designed to enable a lamp to be used on either an arc or incandescent circuit.

ELECTRIC ARC LAMP CARBON. J. Roubal, Prague, Austria-Hungary, 559,752. Filed Dec. 27, 1895.
The surface is incrusted with a mixture of pure carbon and a silicate or boric acid.

Miscellaneous:—

COMPOSITION FOR ELECTRIC INSULATION AND PROCESS OF MAKING SAME. A. Gentzsch, Vienna, Austria-Hungary, 559,376. Filed April 5, 1893.
A composition of matter for electric insulation consisting of shellac and rosin, of birch tar oil and anilin oil, and of arthracene.

PROCESS OF AND MEANS FOR PRODUCING BLEACHING AGENTS. C. Kellner, Vienna, Austria-Hungary, 559,454. Filed Nov. 1, 1892.
Consists in subjecting a solution of chlorids of the metals of the alkalies to the action of an electric current and combining the chlorine liberated at the anode with the alkaline hydrate formed at the cathode in a separate vessel.

ELECTRICAL SAFETY LOCK FOR ELEVATORS. A. C. Hunt, Denver, Colo., 559,529. Filed Jan. 17, 1896.
Actuated by an electric current controlled by the opening of the elevator shaft door.

ELECTRIC BELT. G. N. Moore and R. C. MacCulloch, New York, 559,535. Filed April 17, 1895.
The belt web is folded along the middle lengthwise, and the battery cells having a perforated attaching flange secured to one of the folded parts, and said parts being laced along the open edge.

ELECTRIC HEATER. W. F. Warner, Muncie, Ind., 559,553. Filed Aug. 2, 1895.
A conductor coil, a block forming a non-conducting surface secured in the casing and having a notch at each end and a projection extending out from the notch around which the conductor coil is adapted to be passed.

SAFETY APPLIANCE FOR ELEVATORS. J. H. Tennyson, New York, 559,633. Filed April 20, 1895.
An electric locking device operates a steam supply valve.

Railways and Appliances:—

ELECTRIC RAILWAY. H. Brandenburg, Chicago, Ill., 559,356. Filed March 11, 1895.
A conduit comprising an open slotted metal tube.

ELECTRIC RAILWAY. H. Brandenburg, Chicago, Ill., 559,357. Filed May 2, 1895.
A conduit forming a support for or a part of one of the track rails.

TROLLEY WHEEL. J. McKenna, Johnstown, Pa., 559,461. Filed March 2, 1896.
Comprises a separable, composite flange composed of a disc of copper or similar metal and a supporting disc of substantially the same diameter.

ELECTRICAL CONTACT DEVICE FOR SUBWAYS OR CONDUITS. A. S. Kortz, Springfield, O., and W. P. Allen, Chicago, Ill., 559,586. Filed Nov. 14, 1895.
Consists essentially of spring standards having contacting shoes.

Regulation:—

ELECTRIC CURRENT REGULATOR. A. S. Kortz, Springfield, O., 559,585. Filed Jan. 22, 1894.
Employs a solenoid arranged in the main circuit.

Switches, Cut-Outs, etc.

RHEOSTAT. W. S. Andrews, Schenectady, N. Y., 559,349. Filed Dec. 12, 1895.
A resistance card of insulating material wound with a metallic conductor, and folded upon itself lengthwise so as to bring the ends of the conductor at one end of the card.

ELECTRIC PUSH BUTTON. G. J. Soper, Brooklyn, N. Y., 559,416. Filed May 17, 1895.
Has for its object the hiding of the fastenings of the base plate.

RHEOSTAT. H. P. Davis, Pittsburg, Pa., 559,685. Filed July 10, 1895.
Comprises a plurality of sets of resistance coils arranged eccentrically, two sets of metal plates, respectively connected to the opposite ends of said coils, whereby said coils are joined in series, and a set of contacts directly attached to and supporting one set of said plates.

Telegraphs:—

TELEGRAPHIC KEY. C. G. Burke, Brooklyn, N. Y., 559,479. Filed Nov. 21, 1895.
Involves a coil of wire placed in a magnetic field, adapted by the passage through it of an electric current, to be moved or rotated in such field.

Telephones:—

SWITCHBOARD FOR TELEPHONE EXCHANGES. J. P. Davis, New York, 559,366. Filed Aug. 10, 1895.

A call-receiving board at which all the subscribers' calls are received and from which they are distributed in a uniform manner to the different operators at the multiple board.

SWITCHING APPARATUS FOR TELEPHONE EXCHANGES. J. P. Davis, New York, 559,367. Filed Aug. 10, 1895.

A device for permitting the subscriber to designate to a central station a particular group of subscribers, among which the desired correspondent may be found.

TELEPHONE CIRCUIT FOR POLICE BOXES. C. E. Scribner, Chicago, Ill., 559,409. Filed Jan. 26, 1894.

Eliminates the resistance of the electromagnet from the telephonic circuit while the telephone is in operation.

APPARATUS AND CIRCUIT FOR TELEPHONES. C. E. Scribner, Chicago, Ill., and F. R. McBerty, Downer's Grove, Ill., 559,410. Filed Jan. 8, 1895.

Means for preventing the transmission to a telephonic circuit of rapidly alternating currents, such as are capable of producing sounds in a telephone.

APPARATUS FOR TELEPHONE SWITCHBOARDS. C. E. Scribner, Chicago, Ill., and F. R. McBerty, Downer's Grove, Ill., 559,-411. Filed Feb. 28, 1895.

Adapted to respond to currents in the time circuit and control subsidiary signals, preferably incandescent lamps, for indicating the signal for disconnection.

TELEPHONE TRANSMITTER. L. D. Appleman, Waynesborough, Va., 559,476. Filed May 25, 1895.

A suspended conducting pencil, having its end projecting between the diaphragm and a fixed electrode bearing against the latter.

SYSTEM OF CURRENT SUPPLY FOR TELEPHONES. C. E. Scribner, Chicago, Ill., 559,616. Filed Jan. 8, 1895.

A condenser is interposed in the conductor and the common source of current supply is connected with the severed portions of the conductor through impedance coils.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS ISSUED MAY 12, 1896.

Alarms and Signals:—

DOOR HANDLE WITH ELECTRIC ALARM. A. J. Moulart, Paris, France, 560,043. Filed July 1, 1895.

Details of construction.

ELECTRIC CALL BELL. F. C. Jordan, Wadsworth, O., 560,006. Filed March 20, 1896.

The alarm is given, when desired, by a clock previously arranged for a determined time.

RAILWAY SIGNAL. D. C. Stewart, Warren, O., 560,071. Filed March 9, 1894.

Comprises a depressible bar in juxtaposition to one of the rails of a track and designed to engage the beveled shoulder of a pivoted spring-held arm.

AUTOMATIC RAILWAY SIGNAL SYSTEM. J. W. Lattig, South Bethlehem, Pa., 560,102. Filed April 10, 1896.

A system in which the signal is controlled through the instrumentality of a relay included in a track circuit.

Distribution:—

ALTERNATING CURRENT SYSTEM OF DISTRIBUTION. C. P. Steinmetz, Schenectady, N. Y., 559,913. Filed Feb. 5, 1896.

Comprises transformers having their primaries connected in delta, and their secondaries in "Y," and a neutral or equalizing wire extending from the common junction of the secondaries only.

Dynamos and Motors:—

ARMATURE FOR DYNAMO ELECTRIC MACHINES. H. G. Reist, Schenectady, N. Y., 559,910. Filed Jan. 31, 1896.

An armature spider having a central boss or hub, separate arms radiating therefrom, the arms being provided upon their outer ends with dovetail grooves, and laminæ having dovetail projections fitting in the grooves, thus connecting the arms.

DYNAMO ELECTRIC MACHINE OR ELECTRIC MOTOR. O. Patin and L. Levavasseur, Paris, France, 560,006. Filed June 19, 1893.

A fixed inductor having eight poles alternately positive and negative, a moving armature consisting of ten flat coils and a commutator with conductors for connecting the commutator with the armature coils.

Lamps and Appurtenances:—

ELECTRIC LIGHT FOR BICYCLES. B. B. Hoffman, New York, 559,801. Filed May 24, 1895.

A lantern case, a reflector removably secured therein, spring clips in said case, a lamp socket secured by said clips in said case, a lamp socket secured by said clips beneath said reflector, and a lamp carried in said socket and extending through the lower wall of said reflector.

ELECTRIC ARC LAMP. S. E. Nutting, Chicago, Ill., 559,863. Filed Oct. 18, 1893.

The combination of an arc drawing magnet, a shunt circuit around the arc, and means operated by the magnet for varying the resistance of the shunt circuit around the arc.

ELECTRIC ARC LAMP. A. O. Mackin, Anderson, Ind., 560,039. Filed Oct. 3, 1895.

A self-trimming magazine lamp wherein a large number of carbons may be successively fed into operation automatically.

ELECTRIC LAMP SOCKET. H. W. Leonard, New York, 560,168. Filed June 28, 1890.

Comprises essentially two insulated conductors permanently embedded in a single piece of non-conducting moldable material, the exterior ends of the conductors being located beneath an overhanging ledge forming part of the socket.

Measurement:—

METER FOR ALTERNATING ELECTRIC CURRENTS. T. Duncan, Fort Wayne, Ind., 560,087. Filed Dec. 21, 1891.

In combination a coil traversed by the current to be measured, a revolving secondary cutting the field or fields of force generated by such coil or coils in its revolution, a magnetic path diverter, a retarding device and a registering train.

Miscellaneous:—

ELECTRIC CLOCK. B. Franklin (deceased) and D. H. Fletcher, Chicago, Ill., 559,889. Filed April 11, 1893.

The combination with a clock train, of a driving arbor, a segmental rack for actuating said driving arbor and an electrical shifting device for automatically reversing the direction of movement of said rack at predetermined intervals.

STEERING GEAR FOR SHIPS. M. Pfatischer, Philadelphia, Pa., 559,903. Filed Aug. 24, 1895.

A motor or generator armature, commutator, and adjustable brushes therefor, included in circuit with the said controlling device, a second such armature, commutator, and adjustable brushes, also included in said circuit, and mechanical connections for automatically adjusting the latter brushes simultaneously with the rudder.

ELECTRICAL STEERING GEAR. M. Pfatischer, Philadelphia, Pa., 559,904. Filed Dec. 26, 1895.

Consists in introducing into the field magnet circuit of an electric generator, a current corresponding in direction to the deviation of the controlling handle.

ELECTRIC CIGAR LIGHTER. W. Fisher, Chicago, Ill., 559,939. Filed Oct. 12, 1895.

A transparency is displayed in one or more colors each time the light is used.

THERMOSTAT. W. G. Day, Baltimore, Md., 560,023. Filed Jan. 4, 1895.

Comprises a spring in an electric circuit, and a restraining device of hard rubber, which is softened by abnormal heat.

Railways and Appliances:—

ELECTRICALLY OPERATED RAILWAY SWITCH. A. C. Goetz, Milwaukee, Wis., 559,796. Filed Aug. 24, 1893.

Means for operating switch from platform of car.

AUTOMATIC TRACK SWITCH FOR ELECTRIC RAILWAYS. W. C. Henry, Milwaukee, Wis., 559,800. Filed Dec. 20, 1893.

A trolley wire, supplemental conductors located one in advance of the other along the trolley wire, a track switch points and separate electromagnetic devices, respectively, in circuit with the said supplemental conductors and connected to operate the switch point in opposite directions.

SYSTEM OF ELECTRICAL TRANSPORTATION. P. K. Stern, St. Louis, Mo., 559,872. Filed Sept. 16, 1895.

A vehicle adapted to travel along a route, a primary inducing element arranged along the route, a laminated wheel, mounted on the vehicle and induced current conductors on said wheel.

ELECTRIC RAILWAY. J. H. Guest, Boston, Mass., 560,031. Filed Dec. 3, 1895.

The working conductor is divided into insulated sections which are progressively thrown in and out of connection with the power source by automatically actuated switch devices as the car moves along its course.

TROLLEY WIRE AND TROLLEY THEREFOR. H. R. Keithley, Buffalo, N. Y., 560,097. Filed Aug. 24, 1895.

A trolley wire having two ribs and two grooves, hangers engaging one of said grooves and both ribs, and a trolley wheel engaging both ribs and the other groove.

TROLLEY WIRE AND TROLLEY THEREFOR. H. R. Keithley, New York, 560,098. Filed March 28, 1896.

Similar to above.

Regulation:—

RUNNING COMPOUND WOUND GENERATORS IN MULTIPLE. W. B. Potter, Schenectady, N. Y., 559,907. Filed Feb. 25, 1896.

Consists of a shunt around the series circuit of each of such machines, the shunt being substantially equal in resistance to the resistance of the series coil and its adjusting resistance.

ELECTRIC REGULATOR. R. M. Hunter, Philadelphia, Pa., 560,-035. Filed May 22, 1894.

Consists in the varying of a counter electromotive force independent of that of the power motor.

Switches, Cut-Outs etc:—

ELECTRIC SWITCH. P. G. Tismer, New York, 559,916. Filed March 29, 1895.

An insulated frame for supporting the parts of a rotating arm carrying metallic plates, contact plates secured to the said frame, and a roller bearing lever for suddenly moving the rotating arm.

FUSE CUT-OUT. W. E. Harrington, Philadelphia, Pa., 560,128. Filed June 1, 1894.

Consists in providing a suitable liquid in which a part of or all of the length of the fuse is immersed.

Telegraphs:—

TELEGRAPHIC PRINTING APPARATUS. H. C. Spaulding, Boston, Mass., 559,821. Filed April 23, 1895.

Adapted for large scale printing, such as bulletins.

DISTRICT TELEGRAPH CALL BOX. W. H. Garven, Portland, Ore., 560,093. Filed June 19, 1895.

Provided with means for an answer in return from the central office, indicating that the call has received attention.

Telephones:—

ELECTRIC SWITCHING APPARATUS. W. W. Dean, St. Louis, Mo., 559,792. Filed Jan. 24, 1896.

Relates a form of spring jack and plug.

ELECTRIC TELEPHONE TRANSMITTER. N. Bassett, Philadelphia, Pa., 559,837. Filed Nov. 14, 1895.

A diaphragm, fixed terminal electrodes and movable electrode which bridges said terminal electrodes, and is in electrical contact therewith and which bears against the diaphragm.

SELECTIVE SIGNAL AND LOCKOUT SYSTEM. C. E. Scribner, Chicago, Ill., 559,869. Filed May 18, 1895.

The combination with a telephone line having at two or more substations, lockout boxes adapted to be set by current from a battery connected with the line, of a key adapted to short circuit the lockout boxes to suspend their operation.

TELEPHONE SYSTEM. W. F. Taylor, Montreal, Can., 559,874. Filed Aug. 3, 1894.

A device for closing the circuit through the terminals, which device is automatically reset when the conversation is finished and the telephone receivers hung upon their hooks.

TELEPHONE. T. Berdell, New York, 559,988. Filed March 8, 1895.

A diaphragm mounted in a magnetic field in a position of magnetic equipoise or stable equilibrium.

TELEPHONE. T. Berdell, New York, 559,989. Filed June 19, 1895.

The combination with a magnet, of two independent diaphragms, loosely held in place and adjustment by magnetic force, but out of contact with the magnet.

TELEPHONE. T. Berdell, New York, 559,990. Filed Dec. 7, 1895.

Two swinging diaphragms supported within a case of non-magnetic material between the poles of a magnet, in combination with adjustable regulating rings.

Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

THE MORGAN CONTROLLER AND REVERSING SWITCH FOR SERIES MOTORS.

The controller illustrated herewith was designed by the Morgan Engineering Company, of Alliance, O., with special reference to the requirements of their traveling cranes. The following points have been embodied in the design of the Morgan controller which tend greatly to its mechanical perfection:

The coils are of a shape to permit of their being machine wound and are compactly disposed in the frame, but in a manner which leaves them all equally open to a free circulation of air. There is a complete absence of cable connections in the interior of the frame.

The machine work on this controller, especially at the contact points, has been kept at a minimum in order to reduce the expense of renewals, thus leading to unusual facility in renewals of contact points with the least labor and loss of time possible. There are a larger number of contact points than is generally employed, which increases the fineness of the gradations in the resistance. Both the controlling and reversing of the motor is effected by the movement of one handle whose action is similar to an engine reversing lever and whose position indicates the control similar to the link-motion lever.

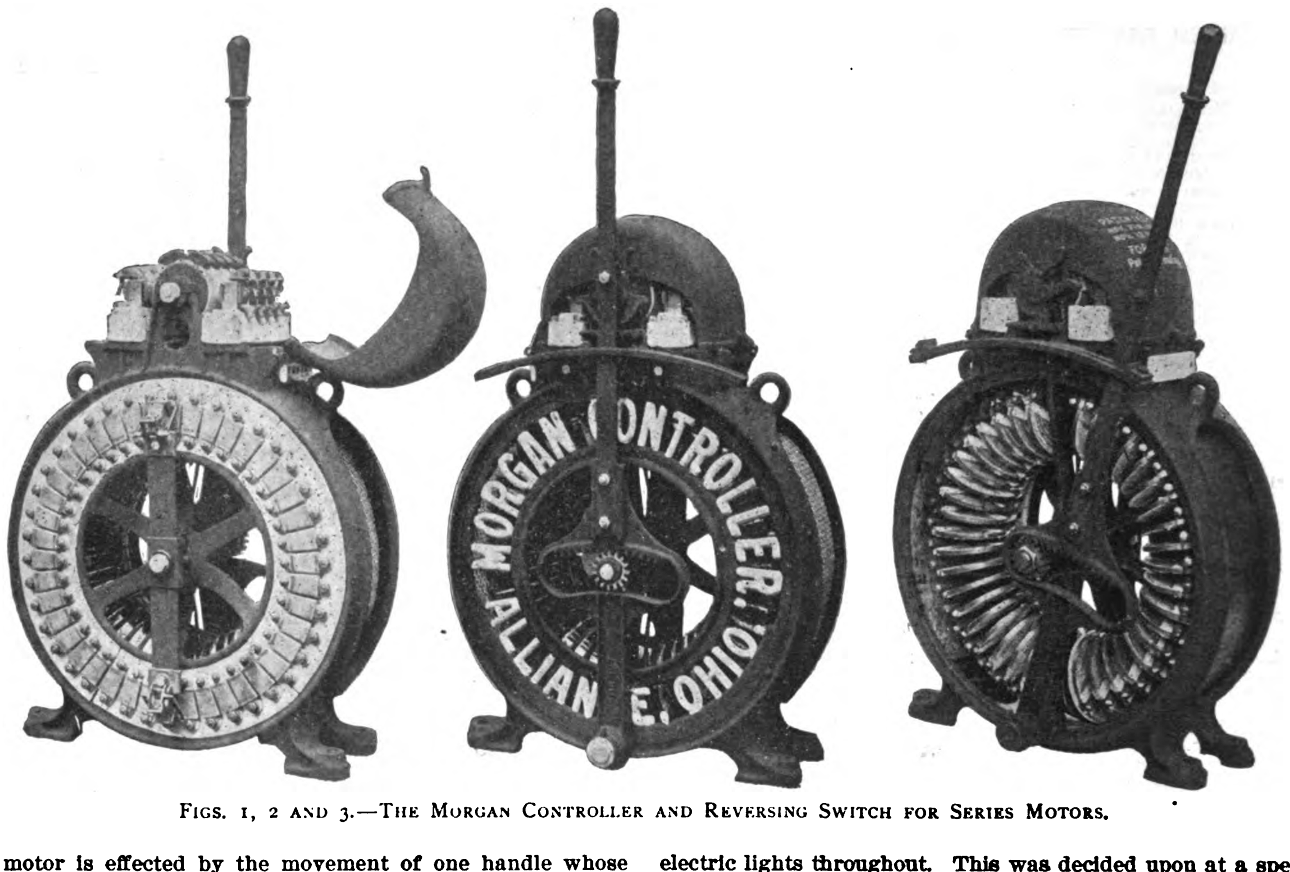
Figs. 1, 2 and 3 give a front and rear views respectively of this apparatus. Within the periphery of a circular skeleton iron frame are placed the resistance coils, the latter being wound in the shape of flat springs and lying radially within the frame. These spools are all connected in series and each alternate one is also connected with a contact piece, the circular row of which is shown in Fig. 1, and over which a contact bar is shown. The current circulates in series through the coils up to the point where the contact bar rests.

The reversing switch is mounted on top of the controller and consists of a porcelain cylinder upon which contact plates are mounted. It is shown uncovered in Fig. 1. The cylinder shaft is provided with a fork at the lever end, and a pin upon the lever engages the fork in passing the vertical position.

The contact pieces on the cylinder are easily removable and the stationary contacts on either side of the cylinder are held only by spring catches which can be loosened in an instant to replace the contacts. The ends of the reversing switch are covered with wire gauze, which, with the cover, shown open in Fig. 1 and closed in Figs. 2 and 3, completely inclose the switch. In places where metal dust and other dirt is liable to make trouble, the wire cloth is replaced by sheet metal. Fig. 3 shows the same view of the apparatus as Fig. 2, but with the back of the frame removed.

A glance at the illustrations will show how the apparatus is operated. With the lever arm vertical, as in Figs. 1 and 2, the current is cut off and the motor is stationary. When the lever is thrown forward one step the circuit is completed through the motor and the whole of the resistance coils in series, and at each successive step of the lever the coils are thrown out of circuit, two at a time, until they are all out and the motor takes the full current. By throwing the lever backward from the vertical position the direction of the motor is reversed, the resistances acting as before.

While this apparatus was designed solely for use with electric cranes, its excellent mechanical design and the simplicity of its operation have made a considerable market for it in other directions. One of its main features of excellence is the large amount of resistance which can be included.



Figs. 1, 2 and 3.—The Morgan Controller and Reversing Switch for Series Motors.

IMPORTANT CONTRACTS FOR CHICAGO WEST SIDE LIGHTING.

Parks, park thoroughfares, and boulevards in the West Town, Chicago, will in the near future be illuminated with electric lights throughout. This was decided upon at a special meeting held last week by the West Park Board of Commissioners.

Three weeks ago bids were advertised for the construction of an electric light plant and for the various articles of machinery necessary in the work. The total amount to be expended for the improvement will be over $90,000.

The following contracts were awarded:

Boilers, Standard Boiler Company, two 250 h. p., $6,300.

Condensers and Pumps, Nordberg Manufacturing Company, Milwaukee, $5,500.

Heaters, Harrison Manufacturing Company, $865.

Engines, Filer & Stowell, Milwaukee, $9,700.

Rope and drive, Dodge Manufacturing Company, $4,100.

Six 150-arc dynamos, Excelsior Electric Co., at $1,484 each.

Arc lamps, Adams-Bagnall, 750 at $22.50 each.

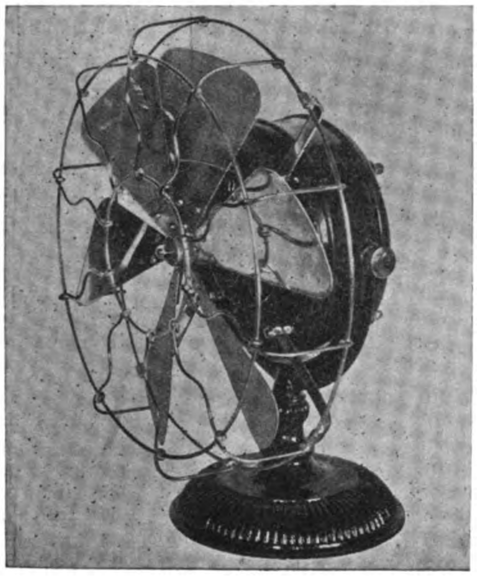
Cables, Washburn & Moen Manufacturing Company, 7½ and 11 3-16 cents a foot.

Switchboard, Western Electric Company, $1,250.

Pulley block and crane, Whiting Foundry Equip. Co., $1,225.

THE G. E. '96 ALTERNATING FAN MOTOR.

THE '96 model alternating current fan motor of the General Electric Company embodies a number of improvements dictated by careful observation of the performances of the fan motors of previous years. Of these improvements, perhaps the most important is the universality of direction which can be given to the draft caused by the revolving blades. The motor field frame being provided with trunnions resting on a yoke, the current of air may be directed at almost any single in a vertical plane, while the yoke is so set in the base that the motor may be moved through a complete circle horizontally and the current be directed toward any point desired. The yoke may also be removed from the base and inserted in a wall bracket. The design of the motor is both simple and ingenious. The field is a ring built up of thin iron punchings with



THE G. E., '96, ALTERNATING FAN MOTOR.

inwardly projecting teeth carrying the field wiring. The armature is a cylinder of iron laminations, with small bare copper rods running through the iron and terminating in copper discs fastened at the end of the core.

There are neither brushes nor commutators, and, in fact, this small fan motor embodies principles similar to those involved in the large General Electric induction motors.

To reduce the friction of the starting and running current the fan is provided with smooth running bearings with hardened steel cones and balls. No oil is required to lubricate this bearing, and as none can be thrown off one of the great drawbacks inherent in fan motor bearings is eliminated. The diameter of the fan is 12 inches and the speed 1,800 revolutions per minute.

TEST OF THE MOYES "COMBINE" WATER TUBE BOILER.

MR. JAY M. WHITHAM, consulting mechanical engineer, of Philadelphia, recently concluded a test on the Moyes "Combine" water tube boiler, at the power station of the Marietta, Pa., Electric Light, Heat and Power Company. The object of the trial was solely to determine the boiler capacity, which was rated at 125 horse-power, based on the evaporation of 30 pounds of water per hour from a feed-water temperature of 100 deg. F. into steam at 70 pounds pressure.

In conducting the test the coal and water were weighed, height of water in boiler noted, and depth of fire at the beginning and end of the test was measured. The test was made during a run of 8.65 hours, and in this time the horse-power developed by the boilers varied between the minimum, 138 horse-power, and the maximum, 179 horse-power, the average for the 8.65 hours run being 161.4 horse-power.

Mr. W. Barnet Le Van, the well-known mechanical engineer, co-operated in the tests as representative of the company. We give below the results of the tests and conclusions:

Moisture in coal	2%
Ash and refuse in coal	11.13%
Moisture in steam by the Barrus calorimeter	0.13 of 1%

(Mr. Le Van says that a steam having 3 per cent. moisture is practically dry, hence 0.13 of 1 per cent. must be very satisfactory to him.)

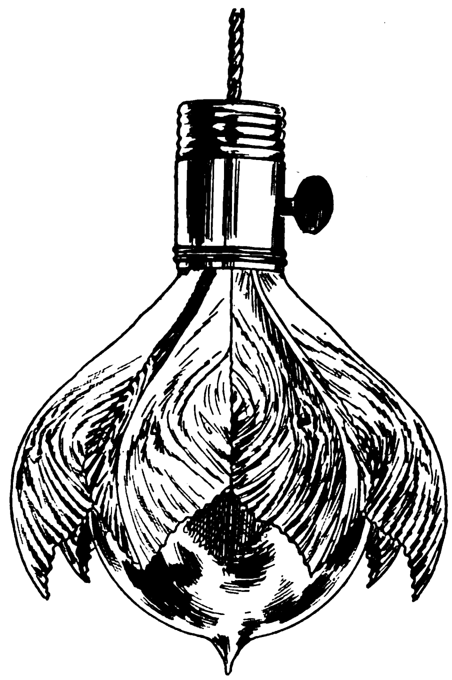
Water evaporated from and at 212 deg. F., per lb of dry coal	9.346 lbs.
Water evaporated from and at 212 deg. F., per lb of combustible	10.52 lbs.
Boiler horse-power actually developed, by basis of 30 lbs. per hour from 100 deg. F., at 70 lbs. pressure, average for 8.65 hours	161.4
Rated boiler horse-power	125
Horse-power developed above rating	29.1%
Pounds of dry coal burned per hour per boiler horse-power developed	3.69
Pounds of wet coal burned per hour per boiler horse-power developed	3.75

CONCLUSIONS.

1. The boiler steams freely and with ease.
2. The steam is remarkably free from moisture, being practically dry.
3. The water level is very steady, not vibrating, under the conditions of working this test, over one inch.
4. The walls of the boiler setting are covered with a plaster of non-conducting material, and were colder than any walls ever noted by the writer. This retention of heat in the setting is conducive to economy.
5. The distribution of the draft in the various passes of the gases was as follows: Draft at stack base, 0.514 inch; second pass, 0.445 inch; top of first pass, 0.394 inch; furnace, 0.242 inch. This shows a skillful proportioning of the flue areas.
6. The fuel burned having over 11 per cent. ash, was not as good as an average quality of Clearfield coal. I have made scores of trials of this coal, covering periods ranging from 8 hours to 6 months, and find that the Clearfield coal usually found in this market has from 4 to 8 per cent. ash, and seldom as high as 10 per cent.
7. The boiler developed with ease 29 per cent. excess capacity above its rating, and with good economy.
8. Mr. Le Van and I are both of the opinion that this boiler, run at its rating, will show about 10 per cent. better economic results. This means that, whereas 3.69 pounds of dry coal an hour were used per boiler horse-power at 29 per cent. excess capacity, only about 3.35 pounds would be required at its rating.
9. The boiler is well suited to supply steam for a steady pull, and also to respond to sudden fluctuations in the demand.

THE McCREARY PAPER LAMP SHADES.

WE illustrate herewith the "Novelty Lamp Shades" that are being introduced by Mr. A. A. McCreary, 136 Liberty street, this city. They are intended for temporary ornamental decoration, and answer that purpose admirably;



THE McCREARY "NOVELTY" SHADE.

while they are also of utilitarian value, as a means of protecting the bulb from dust, dirt, etc. The paper shades are artistically crimped, and fit the bulb in such a way as to make it seem like the heart of a big lily. A set will be sent to any

address by the vendors, on receipt of 35 cents. Such shades should find a wide application, especially in summer time. They are made in white and eight colors.

THE EMERSON ELECTRIC MFG. CO.

We have received the 1896 catalogue of the Emerson Electric Manufacturing Company, of St. Louis, Mo., containing descriptions and illustrations of their alternating current motors for fan and power purposes. Their list of fans is very varied. Among their specialties for the season are their 16-inch fan motor for both 16,000 alternation systems and 7,200 alternation systems, and their "Emerson" power motor. This machine, giving an efficiency of 65 to 80 per cent., may be run on one side of two or three-phase systems with only one transformer. It is non-synchronous, and has speed regulations within 5 per cent. Its starting power is 50 per cent. in excess of rated power, and its running power is 50 per cent. in excess of rated capacity. The firm construct special motors for sewing machines, dental and other work.

KOCH WOVEN WIRE BRUSHES.

Messrs. Goldmark & Wallace, 29 Chambers street, City, are selling agents for J. C. Koch, Hohenlunburg, Germany, manufacturers of the celebrated woven wire tube dynamo brushes. These brushes are the result of numerous practical trials and experiments. The mesh of this brush is composed of finely drawn pure electrolytic copper wire, diagonally woven, which is surrounded by a mantle of copper wire woven like lace. The two weavings are connected with small aluminum tubes, making the brush very porous. The tubes also increase the elasticity of the brushes and permit them, if desired, to be used entirely without guards, or with guards drawn well away from the bearing end of the brushes.

These brushes do not cut the commutator. No filing is required to keep them in shape and they are quite noiseless.

Messrs. Goldmark & Wallace will be pleased to send a set of these brushes on trial on information as to the size required.

BIDS WANTED AT ONCE.

The Port Clinton Electric Light and Power Company, of Port Clinton, O., will receive bids for boilers, engines, dynamos, etc., for an electric light and power plant, up to noon on Thursday, May 28, 1896. Specifications are on file with C. I. York, secretary.

BIDS WANTED FOR LOUISIANA, MO.

The present contract for lighting the streets of Louisiana, Mo. (a city of about 6,000 people, 100 miles north of St. Louis, on the Mississippi River), will expire about October 1, at which time, or before, the city council will probably make arrangements for a plant operated under city control, make a contract with the present company, or accept a bid from some other party. Louisiana is peculiarly located for the erection of a plant very economically, owing to the city not being scattered. The mayor is Henry L. Hart, to whom all inquiries should be mailed.

THE WEBSTER VACUUM SYSTEM OF STEAM HEATING.

Warren, Webster & Co., of Camden, N. J., have issued an illustrated catalogue describing their system of heating feed water for boilers, and also of warming buildings within a radius of 2,000 feet from a power house, by utilization of exhaust steam, without causing back pressure upon the engines. The vacuum system of steam heating has been extensively adopted and is generally familiar to steam users in the United States. The present catalogue considers a refinement of the system as heretofore applied, whereby thorough control, as well as more economical and efficient use of exhaust or live steam is secured for either heating or drying purposes. The system is rendered self-controlling by means of thermostatic water and air relief valves, which are fully described in the catalogue.

THE FASHIONING OF A LAMP.

Under the above title the Bryan-Marsh Company, 136 Liberty street, New York, have issued a pamphlet descriptive of the methods employed in the manufacture of incandescent lamps at the company's factory at Marlborough, Mass. Supplementing this description is an illustrated catalogue of the numerous styles of incandescent lamps manufactured by this company, ranging from a one-quarter to a three-hundred candle-power lamp for all purposes.

They are made in all varieties of sizes, shapes and colors suitable for ornamental and decorative lighting of all kinds, and considerable attention is given to high efficiency battery lamps which are made for bicycle, dental, kinetoscope and other special uses.

THE ELECTRICAL EQUIPMENT FOR BROOKLYN BRIDGE.

The trustees of the New York and Brooklyn Bridge, at their meeting last week awarded contracts for the new electrical plant for the bridge, as follows: For twenty passenger cars, provided with electric motors, to the Pullman Palace Car Company, at $3,200 each; for two electric generators, to Walker Manufacturing Company, at $15,849; for two six hundred horsepower engines, to the Southwark Foundry and Machine Company, at $16,400; for two boilers, of a combined 400 horsepower, to the Babcock & Wilcox Company, at $4,350, the highest bid received.

THE C. W. HUNT CO.'S ROPE TRANSMISSION.

"Manila Rope" is the title of an instructive catalogue published by The C. W. Hunt Company, of New York, which contains a brief treatise for engineers on ropes used for the transmission of power, together with formulæ, tables and data useful in mill engineering. For transmission purposes the company makes a specialty of a selected manila fiber, known under the trade name of "Stevedore." Two kinds of rope are made from this; one spliced endless for running over large sheaves, and the other for use with the usual pulley blocks of from 8 to 16 inches diameter. A plumbago lubricant is used in laying up this rope which reduces the internal friction of the fibers on each other in bending over the pulleys and also renders the rope nearly waterproof, so that but very little moisture is absorbed even in a heavy rain in an outdoor transmission.

NEW YORK NOTES.

W. R. OSTRANDER & COMPANY are now occupying their new quarters at 22 Dey street, with increased facilities for carrying on their large business in bells, annunciators, push-buttons, etc. In addition to the above, their stock of electric light supplies is replete with all that is newest and best.

H. B. COHO & COMPANY, of New York, have just issued a neat little brochure, giving an illustrated description of the various goods which they represent. First are shown some illustrations of the Eddy dynamos, motors and platers; then the Royal alternator and transformer. Following these are illustrations and price lists of the Horton voltmeters, Crown woven wire brushes, Peerless soldering stick and commutator compound, theatre dimmers, rheostats, fan motors, and fiber-graphite commutator brushes. A page is also devoted to the Bradley gas generator. Altogether the little book is useful to every manager of a central station or isolated plant.

THE INTERNATIONAL ELECTRIC COMPANY, 76 Beekman street, New York, have just completed a large induction coil which is to be used especially in X-ray work. Mounted on its base it stands 23 inches high; the base measurements being 23 x 43 inches, while the coil itself is 23 inches long with a diameter of 13½ inches. The primary is made of No. 5 wire in two layers of 153 turns each, with a diameter of 3 inches, while the secondary is of No. 36 wire, of which it has been estimated about 70 miles were used in the construction. The spark length is 12 inches. It is hansomely mounted according to the style adopted by this company in finishing their instruments.

WESTERN NOTES.

THE AKRON SMOKING PIPE COMPANY, manufacturers of the Fenton porcelain insulating tubes, cleats and knobs, have removed their general office to Mogadore, Ohio.

THE ELECTRIC APPLIANCE COMPANY have succeeded in producing, with a few slight changes from the regular Upton arc lamp, a lamp that will burn 30 hours with a single pair of carbons. This lamp is meeting with much favor and will probably largely displace the regular 10, 12 and 15 hour lamps. In addition to its great convenience, the question of its greater economy is a point which cannot be overlooked.

NEW ENGLAND NOTES.

THE W. S. HILL ELECTRIC COMPANY have made a change, having organized a new company under the laws of Massachusetts with $70,000 capital. With their new and commodious factory, they will be in a better position than ever before to handle their business.

Department News Items will be found in advertising pages.

THE
Electrical Engineer.

Vol. XXI. JUNE 3, 1896. No. 422.

ELECTRIC TRANSPORTATION.

THE BERGEN COUNTY TRACTION COMPANY'S SYSTEM.

THE west bank of the Hudson River opposite the upper part of New York City presents one of the most difficult obstacles to street railway travel that could well be found; as for several miles south from the Palisades the continuation of this range of cliffs is so little removed from the vertical that an elevator seems more feasible than a trolley car in reaching the summit of the range. In fact, elevators were adopted some time ago by the West Shore Railroad at the terminus of the Forty-second street ferry from New York for making this ascent, and later a street railway line was attempted at Fort Lee. The latter had to be abandoned, as the grades were found impracticable at that point. The Bergen County Traction Company, however, found a practical spot for crossing the cliffs at Pleasant Valley, about a mile south of Fort Lee. The road over the mountain was then constructed, having for its terminus Pleasant Valley at the Hudson River end and Englewood at its western end. The right of way is being secured for a branch road to Hackensack, the county seat of Bergen County, and the company's charter provides for a number of other branches covering a considerable area in Bergen County. The ferry formerly running from 130th street, New York, to Fort Lee, was purchased by this company, and the New Jersey terminus was moved down to Pleasant Valley, directly in front of the company's power house on the shore. Fig. 1 gives a view of the new ferry slip and power-house, taken from the river, and Fig. 2 shows the New York terminus of the ferry, which is close to the Grant Monument in Riverside Park.

THE POWER HOUSE.

The power house, shown in Fig. 3, is a commodious building 111 feet 4 inches by 74 feet 4 inches, built on the side hill some 200 feet back from the river. The building is built of hard burned red brick laid with red mortar, the trimmings being of Pennsylvania bluestone. The roof is slate and supported on Berlin Iron Bridge Company's trusses, which span from the partition wall between the boiler room and engine room to the outer walls of the building. Both the engine room and boiler room are lighted on three sides with very large windows with double sashes, which will be seen in the illustrations, and between the windows pilasters are built into the side walls, giving the building an appearance of massiveness. Monitor ventilators are used upon the roofs of both rooms, and the whole of the lighting and ventilating appointments make the building unusually comfortable in these respects. The construction of the buildings was done by J. W. Ferguson, of Paterson, N. J. The general plan of the building and the location of the machinery will be seen in the diagram, Fig. 4.

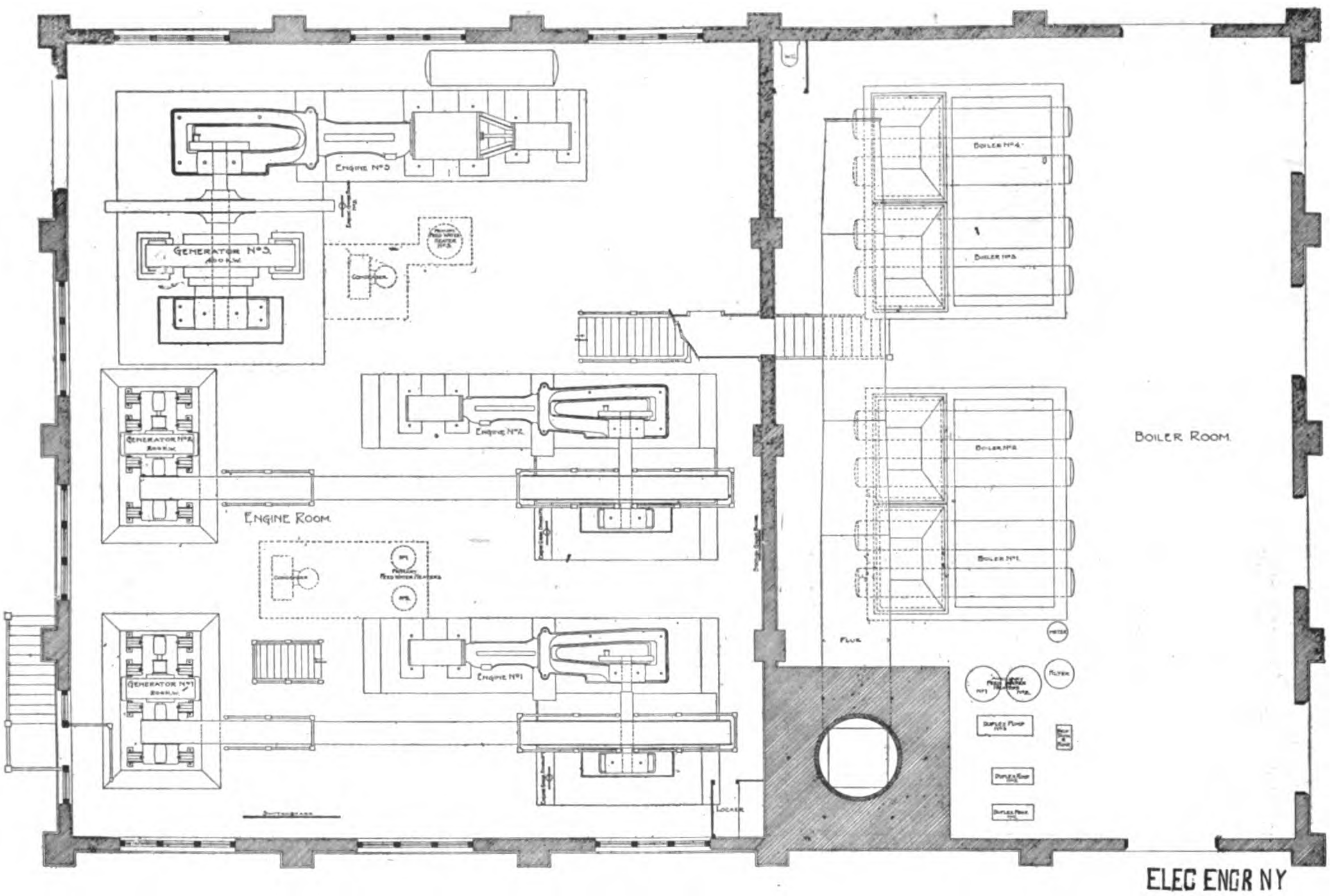


FIG. 4.—PLAN OF ENGINE, DYNAMO AND BOILER ARRANGEMENT, BERGEN CO. TRACTION CO.—FORD & BACON, ENGINEERS.

ENGINE ROOM.

The engine room occupies the southern end of the power house, and is handsomely finished and painted throughout. The equipment of the engine room is divided into two equal units, which are exact duplicates of each other, and provision has been made for a third unit, which will be equal to both of those already installed. The capacity of the plant can therefore be

Fig. 1.—View of Power House from River.

doubled without making any alterations on the building. The two engines now installed are single cylinder, of the Allis-Corliss type and will be seen in Fig. 5. The cylinders are 20 inches by 42 inches, and each engine is belted directly to a 200-kilowatt General Electric multipolar generator. The engines are run either condensing or non-condensing, according to the load on the line, and at a speed of 80 revolutions per minute. Two separate eccentrics are used on these engines, which permit the steam to follow ⅞ of the stroke, if necessary, on overload. The generators are placed behind the cylinders of the engines, and the belts, supplied by the Page Belting Company, run below the floor, in a basement, where the piping is situated. Fig. 6 shows a view of the generators. The switch-

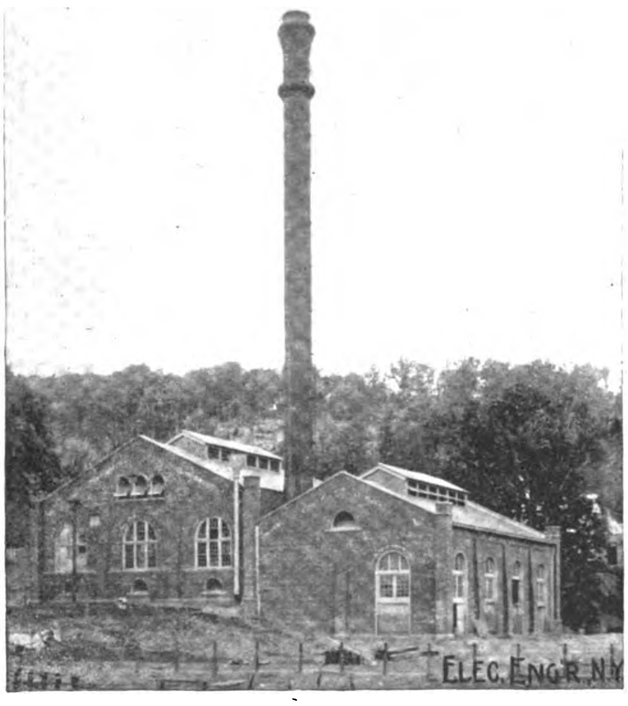


Fig. 3.—Power House, Bergen County Traction Co.

board, the location of which is shown on the plan, Fig. 4, is the standard black enamel slate board of the General Electric Company, and contains three panels. Two of these are for the two generators and contain Weston ammeters and voltmeters, and General Electric automatic cut-outs, resistance boxes and lightning arresters. The third panel contains switches and instruments for the four feeders to the line. Space at either end of the board is allowed for the addition of extra generator or feeder panels. The station gauge board is somewhat novel in being made of enameled slate instead of wood, as ordinarily seen. Its trimmings are of nickel and it contains an eight-day clock, a Crosby recording steam gauge, and a vacuum gauge. In the center of the board a nickel nameplate contains the name of Ford & Bacon, the mechanical and electrical engineers, by whom the plant was designed. The only other apparatus seen in the engine room is the Spencer damper regulator water column and the valve stands, which are brought

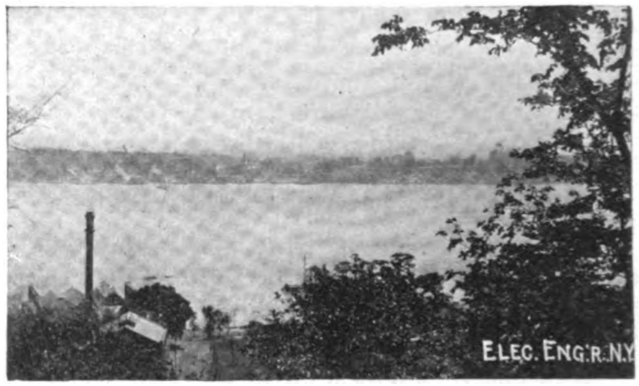


Fig. 2.—A Glimpse of New York from the Palisades.

through the floor. Absolutely no piping whatever is seen in the engine room, it being all contained in a basement below the engines. The piping is all supported on separate special foundations of its own.

All the machines in the engine room are painted in royal blue with gilt striping, and, together with the neat finish of the building itself, make a particularly neat and attractive room. The night lighting is supplied by two arc and twenty incandescent lamps, the latter being distributed around the side walls.

BOILER AND PUMP ROOM.

The boiler room, separated from the engine room by a heavy partition wall, is 7½ feet below the basement level of the latter, which makes it nearly on a level with the water front, where the coal is landed. This room contains in one side two 250-horse-power Heine safety boilers, which are now run at 100 lbs. pressure, and have been tested up to 165 lbs. These boilers occupy only half the available floor space in the boiler room, which will permit of its capacity being doubled, corresponding to the engine room extension. Figs. 7 and 8 give views of the boiler and pump room. To the right of the boilers are installed two Geo. F. Blake M'f'g. Co.'s boiler

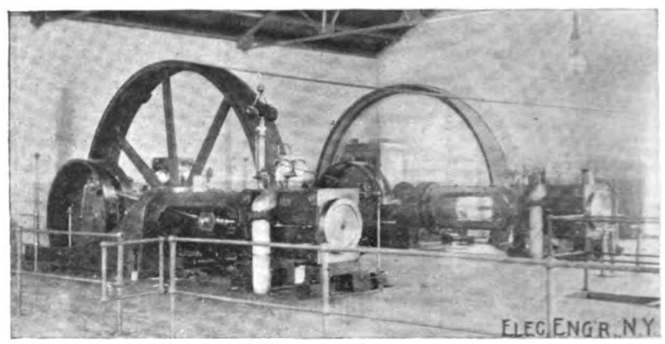


Fig. 5.—View of Engines in Power House.

feed pumps, one drip tank and one Goubert feed water heater. The stack rises from the back of the boilers at the partition wall of the building. This is of steel and is self-supporting. It rises to a height of 140 feet and is 6 feet 6 inches in diameter. This height is, under usual circumstances, considerably greater than would be necessary for this size of plant, but fearing that its position directly under the cliff would affect the draught, it was made higher than usual for its capacity. The stack was furnished and mounted by the Warden Manufacturing Company, of Philadelphia.

The piping on the live steam side of the system is all in duplicate, from the boiler outlet to the steam engine throttle valve. The duplication is not done, however, in the usual way, by having two pipes, each of the full capacity required, but by a method devised by Mr. George H. Davis, a member of the firm of Ford & Bacon. In the Davis system the combined area of the two pipes equals the area that would be required for a single pipe of the usual system, and both the small pipes are in use all the time. If an accident occurs to either pipe it is shut

down and the other one is forced during the short time necessary to make the repairs. This system of double piping, which has been found to answer all the requirements for which the full size duplicate pipes are installed, costs but little more than the single large piping system, and, of course, far less than a large pipe duplicate system. The pipe fitting was done by Benjamin F. Shaw & Co., and the pipe covering by the H. W. Johns Manufacturing Company. The piping connections to and from the engines are all made in a basement specially designed for that purpose. After passing to the separators the steam pipes rise vertically through the floor to the lower side of the steam chests of the engines. The exhaust similarly passes vertically through the floor down to the basement, where the piping is arranged so that the steam can exhaust directly into the atmosphere, or by closing this and opening another branch the steam is carried to a Blake twin upright jet condenser. The valve stands, shown on the plan (Fig. 4) of the engine room, indicate the location of the gate valves in the exhaust, the condenser and the air pump, which are directly underneath the engine room floor.

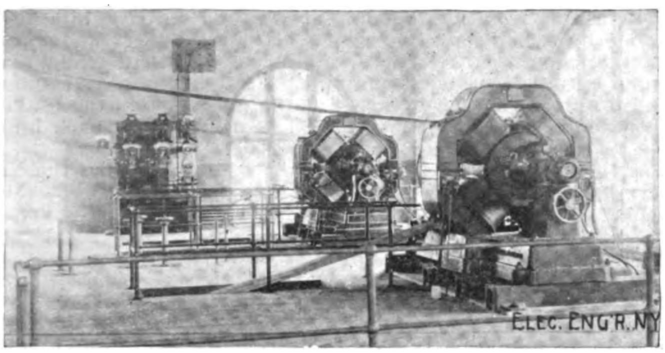


FIG. 6.—VIEW OF DYNAMOS AND SWITCHBOARD IN POWER HOUSE.

LINE AND TRACK CONSTRUCTION.

The part of the line which presented the greatest difficulty to the engineers was the first mile after leaving the ferry. Here the road starts off with a grade of 8 per cent., which extends for a considerable distance in a nearly westerly direction until the first loop approach is reached, showed in Fig. 9, which curves around the company's water storage reservoir, from which the water for the boiler supply is secured for about nine months in the year. Here the grade drops to 6½ per cent. and the road takes a southerly direction for about a quarter of a mile. At this point a safety switchback is built, and the car passes back in a northern direction to a second loop approach, where it again resumes its general westerly direction. The grade is uniformly 6½ per cent. from the lowest loop approach to the top of the mountain.

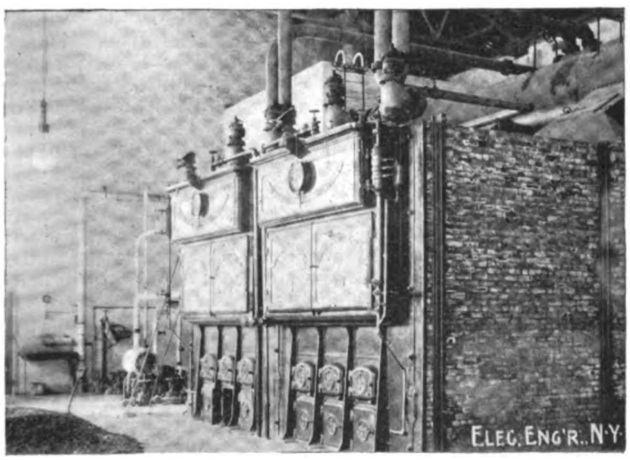


FIG. 7.—BOILER ROOM, BERGEN COUNTY TRACTION CO.

The rails throughout are 60-lb. T, and are laid on cross-ties. The rails were furnished by the Pennsylvania Steel Company and the track was built by Kearns & Egan, the special track work being done by the Wharton Switch Company. The downgrade side of the safety switchback is continued by a reverse grade which would stop a car, even if the brakes should fail to work properly. In passing from one side of the switchback to the other track automatic spring switches are used which do not require any manipulation while running over them in either direction. The entire road along the side of the cliff had to be blasted out of solid rock and at short intervals retaining walls have been built on the outside edge of the road. All of this part of the road is ballasted with broken stone obtained from the cuttings.

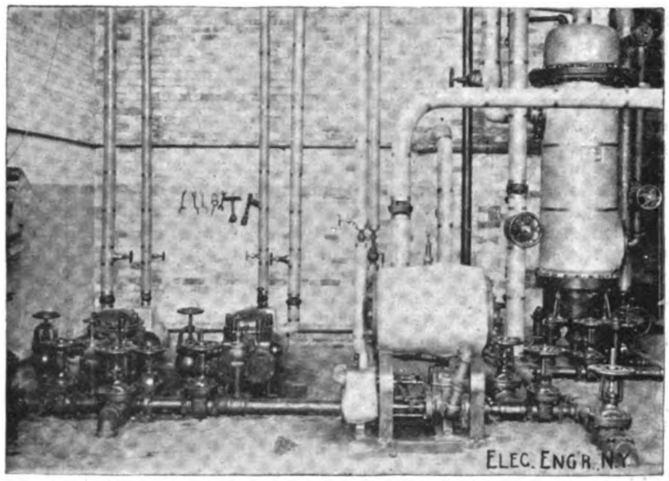


FIG. 8.—PUMP ROOM IN POWER HOUSE.

FIG. 9.—A LOOP AT THE FOOT OF THE PALISADES.

The overhead construction on this part of the line is entirely side bracket construction, the poles for which are set in the solid rock. In some places the poles for guy wires and the pull-off wires for the loop approaches are 60 feet in height because of the steep slopes at certain points. The trolley line between Pleasant Valley and Englewood is fed by feeders, for which a separate pole line is run down the side of the cliff to

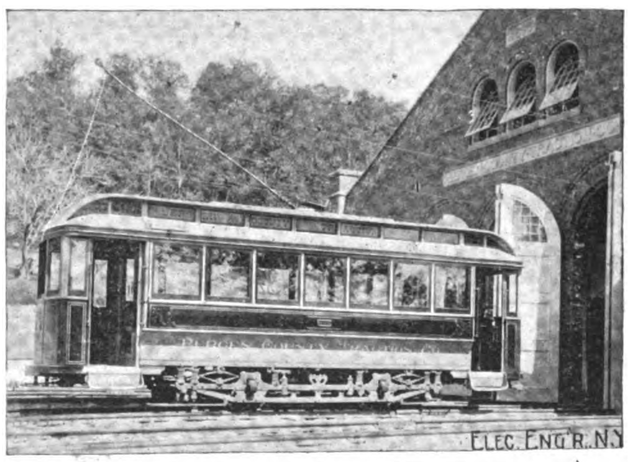


FIG. 10.—VESTIBULE CAR, BERGEN COUNTY TRACTION CO.

save the length of copper wire caused by the detours of the line in ascending the cliff. In some places the separate feeder line runs nearly vertical down the face of the cliff. The road is a single track construction with turnouts. This construction was done by the White Crosby Company, and was one of the greatest difficulty, as well as of the finest workmanship.

THE CARS AND CAR HOUSE.

The car house, a portion of which is shown in Fig. 10, is situated about 100 feet west of the power house and is of the same style of architecture as the latter. It is 104 feet 4 inches in length and 74 feet 4 inches wide. It contains five tracks, and car pits are built under the three right hand tracks. The building is entirely open inside except at the corner, shown in the illustration, where an office and work room are partitioned off for the use of the employés of the road.

The cars are handsomely finished and are fitted up in dark wood, with bronze trimmings. They are vestibuled on both ends and are 20 feet long inside, with an 8-foot wheel base. They have General Electric equipments, consisting of two 1,200 motors, each capable of developing 40 horse-power. The car bodies were built by the St. Louis Car Company and by the Jackson & Sharpe Company, and are lighted by ten incandescent lamps, nine inside and one outside of each car. The brakes and fare registers were manufactured by the Stirling Supply Company.

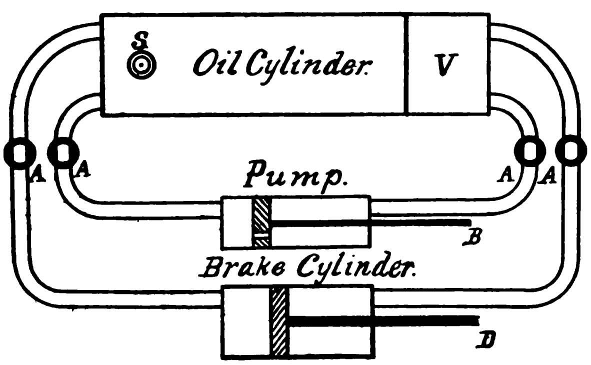
The officers of the Bergen County Traction Company are: President, Jacob E. Ridgeway; vice-president, W. H. Clark; secretary and treasurer, W. N. Barrows, and superintendent, E. W. Lawson.

The mechanical and electrical engineering work was done by Ford & Bacon and the civil engineering work by Wm. Hunter. The engineering work presented many difficulties which have been ably overcome, and the road in every respect is a model of excellent engineering skill.

A NEW HYDRAULIC BRAKE FOR STREET CARS.

ON Tuesday afternoon, May 26, an exhibition of a new hydraulic brake was given in Brooklyn on one of the cars of the Brooklyn City Railroad Company. Car No. 3701, of the Myrtle and Gates avenue division, was fitted up with the new brake manufactured by the Lombard Hydraulic Brake Company, 51 Hampshire street, Boston, and through the courtesy of Mr. G. W. Goodwin, division superintendent, a number of street railway engineers made the trip from Fulton Ferry to Richmond Hill and back to test the operation of the brake.

A general idea of the mechanism is shown by the accompany-



ARRANGEMENT OF LOMBARD HYDRAULIC STREET CAR BRAKE.

ing diagrammatic illustration. The large cylinder shown on top is divided into two separate compartments, one of which contains oil at a pressure of about 220 lbs., which may vary somewhat with the grades to be traveled and the frequency with which the brake is to be used. There are two pipe connections at each end of these cylinders, as shown, one set connecting the oil chamber and vacuum chamber, V, through the pump, whose piston rod, B, is geared to the car axle, and the other pair of pipes connecting the same cylinders through the brake cylinder, whose piston rod acts directly on the brake beam. A safety valve, S, is placed upon the oil cylinder in case the pressure of oil should become too great. It consists of a flat cylindrical box, whose outer face is made of a thin disc of metal perforated by a pinhole at the center. Behind this hole a screw presses just hard enough to prevent the oil escaping when at its maximum pressure, but if the pressure should rise above the point for which the gauge is set, the front disc is pressed out and allows some of the oil to escape, thus reducing the pressure. The operation is as follows: A valve is opened to the outside air, which is pumped into the oil cylinder until the required pressure is obtained, when the valve is closed. The valves AAAA in practice are combined into one four-way valve, and when this is opened the pressure from the oil cylinder is transmitted to the brake cylinder piston, which moves forward and actuates the brake beam according to the amount of oil admitted behind it. The important feature of this admission valve is that it allows the oil to pass when the hand lever is moved and shuts it off when the lever stops, in no matter what position in its range. Thus a movement of an inch on the hand lever puts a slight pressure on the wheels, which remains constant while the lever keeps its position, and is increased if the lever is turned forward; but if it is turned off, the oil escapes from the brake cylinder into the vacuum by an outside port, not shown, and from the vacuum it falls by gravity into the pump, by which it is returned to the oil cylinders under its original pressure. It will therefore be seen that, while the pump is running constantly, its piston is moving in a vacuum and it absorbs no power except at the moment that the brake is turned off, when it pumps the oil used in braking back into the oil tank.

As the brake is used and released, it will be seen that the oil travels in a closed circuit from the oil cylinder to the brake cylinder, then to the vacuum chamber, from there to the pump, and, lastly, back to the oil cylinder, into which it is forced at its original pressure. The entire operation is controlled by the movement of one hand lever, and the brake is designed to be used constantly, not as an emergency brake. It is attached at the same point of the brake beam that the ordinary hand brake is fastened, and the use of one is entirely independent and does not interfere with the use of the other.

On the return trip several trials were made to test the efficiency of the brake in making quick stops. With a 32-foot car running at about 22 miles per hour the stop was made in two car lengths from the place the brake was applied. At 17 miles per hour, the same car was stopped in 36 feet, while at the ordinary rate of 8 or 9 miles per hour, the car was easily stopped within 6 or 8 feet.

POWER TRANSMISSION.

ELECTRICAL PLANT OF THE SILVER LAKE MINES.

A FEW months ago we described the interesting power transmission plant installed by the General Electric Company at the Silver Lake Mines of Mr. E. G. Stoiber, at Silverton, Col. The introduction of electricity into the operation of the mines has resulted in economy so noticeable that an increase in the plant is now being made to provide for an extension of the system in the mines and to reinforce the water power, which is not sufficient to furnish all the power required throughout the year.

Two cross compound Corliss engines, with cylinders 24 x 46 x 48 inches, each engine of 850 indicated horse-power, are now being set up, together with water tube boilers, mechanical stokers, coal and ash conveyors, feed water heaters, separators, water meter and coal weighers, the whole making what will be the most thoroughly modern steam plant in the State.

The difference between the cost of coal at the power house and its cost at the mine, which is at greater elevation by some 2,500 feet, is such that the saving effected, even when steam power is used for generating purposes, will insure an ample return on the investment, while the economy induced by the use of the water power is considerably greater. Mr. Stoiber, therefore, feels that in adopting electricity for the operation of his mines he has greatly diminished the cost of working them.

The present plant now in operation consists of two 150 kilowatt, three-phase, water driven generators, supplying current to one 100 horse-power motor for the mill, one 100 horse-power motor for the air compressor, one 75 horse-power motor for the hoist, one 15 horse-power motor for the pump, one of 1 horse-power for a blower and to incandescent lights scattered throughout the station, mill and mine. The additional plant will consist of two 150 kilowatt generators, one 100 horse-power motor for the mill; one 15 horse-power motor to drive a pump, and two of 10 horse-power for blowers, forges and miscellaneous machinery. To eventually utilize to the full the capacity of the steam and water power plants additional and larger generators will be set up.

Not the least interesting feature of this installation is that, although the entire output of electrical energy is to be used in the operation of a single mining property, it will be, when completed, the largest electric power plant in the State of Colorado.

ELECTRIC LIGHTING.

CHARGING FOR ELECTRIC LIGHTING SERVICE.

BY ARTHUR J. FARNSWORTH.

IT is rather curious that in so extensive and carefully developed an industry as electric lighting the usual methods of charging customers remain so crude and inaccurate. Even in the largest companies the system is apt to be far from perfect, and there is little doubt that customers are sometimes supplied with current at an actual loss. In the smaller companies, located in country towns, this unsatisfactory and unjust condition almost always obtains in an exaggerated degree. The problem undoubtedly is a difficult one, but it would appear that in many cases the fundamental principles and the features that a desirable system should possess are not fully understood. The writer wishes to make a simple exposition of these principles, to note the defects in the common methods, and to call attention particularly to a system in which some of these defects have been removed.

The subject has not been without attention, and several methods, excellent as partial solutions of the problem, have been suggested, as well as a multitude of mathematical formulas. The latter have for the most part tended to increase the confusion and uncertainty that already existed, and their use is to be discouraged. The condition of no two stations will be exactly alike, and even if it were possible to deduce equations for the various cases that occur, they would be so complicated, and take so much time in their application, as to become practically useless. Mathematical accuracy is by no means the only or even the most important consideration. A system to be successful must be simple and popular, as well as precise, and have a tendency to promote current consumption. None of the present methods appears to perfectly fulfill these requirements.

All operating expenses may be divided into three distinct classes, based upon the manner in which they should be portioned among the customers.

Class A will contain those items which should be shared equally by each customer, irrespective of size, because the benefit to each is the same.

Class B will contain expenses which should be divided among the customers proportionally to the size of their equipment.

Class C will be the remaining operating expenses, all of which are some function of the customers' current consumption.

As an illustration, in a small alternating current station, the operating expenses might be classified as follows:

Class A.—All office expenses, including stationery, stamps, advertising, telephone, heating and lighting, clerical service, etc. Also meter reading and repairs, stable expenses, and all salaries and wages, except those that are only paid during part of the time when the load is unusually heavy.

Class B.—Interest on the total investment, depreciation, taxes and insurance on all property owned by the company, except stables, which are provided for in Class A. Also municipal concessions, energy wasted in transformer core loss, extra labor necessary during heavy load and a contingency fund to cover legal and incidental expenses.

Class C.—Coal, oil, waste, water tax, ash removals, loss of energy in transmission lines, boiler, engine, and dynamo repairs, engine room supplies, etc., and all operating expenses which are any function of the load.

It will be noticed that the items in Class A are in no way affected by the equipment or consumption, and are made necessary by the mere existence of consumers as such. All consumers, therefore, since the benefit to each is the same, should contribute the same amount towards the defrayal of these expenses. The items of the second class will depend in amount upon the capacity of the station, and since it is correct to assume that each individual equipment is suitable for its average load, this class of expenses should be divided among the consumers proportionally to their equipment. The items specified in Class C, of course, imply that in the station under consideration several units are in use, the number at any time depending more or less upon the load.

This tabulated statement, as given, may not be entirely correct, and the classification may vary considerably with circumstances. Some items might perhaps properly belong to more than one class, and for the disposition of such the manager must rely upon his judgment. It is not intended to discuss this question here, and the table is given merely as an illustration of the general principles of classifying operating expenses according to the manner in which they affect the cost of supplying customers.

The greater part of the difficulty of determining the cost of supplying current lies in fixing the relation of the various Class C items to the station output. As the efficiency of the generating plant is constantly changing with the load, it will cost more to produce a kilowatt hour at one time than at another, and this variation should be determined and allowed for if possible. The several factors are numerous and incalculable to any accurate degree. The only practical method will be to obtain actual, running data, extending over a considerable period of time and covering as many conditions as possible. For instance, the coal may vary considerably in quality. One fireman may do better than the next, or perhaps during portions of the year it will be advisable to run condensing and at other times non-condensing. What is desired is the knowledge how much a kilowatt hour is costing at any hour of any day in the year, and with a little care and patience data sufficiently accurate can be obtained.

Knowing that the cost of supplying a customer with current will depend somewhat upon the time at which it is produced and very largely upon the amount, how shall it be sold? Two excellent methods of charging different rates for current at different portions of the day, and which may be included in any general system of charge, have been suggested by Messrs. Wright and Kapp. It is therefore not necessary to dwell upon this point in selecting the best general system. The problem is, What is the best general method; one that shall be at once just, simple, popular and tend to promote consumption? It must be capable of showing the minimum annual charge at which it will pay to accept a customer and make it equally profitable to supply a given amount of current to a number of small consumers as to one large one.

The system commonly used in small stations of charging a fixed amount per kilowatt hour under all circumstances is highly improper. It is these stations which operate under the greatest extremes, and this system, if it is to be used at all, should only be used by such of the larger companies as have a nearly constant load. During a customer's absence, which may last months, it will take no account whatever of his A and B expenses, although they continue to go on, and it will be some time after his return before this loss is made up. It also leads to a false idea in regard to soliciting new business among small consumers, and as it gives no clue as to where the line should be drawn, it will almost invariably result in the company supplying a class of customers that cannot prove anything but a continual source of loss. Another objectionable feature of this system is that it tends to decrease rather than promote consumption, for the reason that the benefits are all in favor of the small consumer. The result of this, of course, will be to encourage and increase business among the most undesirable or even dangerous class, and to prevent much consumption upon a large scale, because of the enormous charges. As a matter of fact, when this system is used discounts are almost always made to the largest consumers, but it is easy to distinguish this from the true discount system by the great variation and lack of method with which such discounts are given. At best it is little better than guess-work, and it is probably just to say that bills made out upon this basis are almost never correct.

If guess-work is necessary, it would be preferable to charge customers an arbitrary rate per month or year, based entirely upon judgment and experience, and thus save the cost of meters.

The discount system is a step in advance, but, like the other, takes no account of the A and B items during a customer's absence or varying loads. It is only when the customer is consuming his average current that these items are properly allowed for, and if the monthly consumption should be greater or less than usual, the charge will be correspondingly too great or too small, although the variation from the true amount will be very much less than with the previous system. This point seems not to be generally understood. It is also claimed for the discount system that it has a strong tendency to promote consumption, and this is undoubtedly so. By means of the discounts it is endeavored to make the actual rate for current the same in each case, but the large consumers will be getting a greater return for their money, because the fixed charges in their case are a smaller part of the whole.

In order to insure against a customer's A and B expenses becoming a source of loss under any circumstances, another system has been made use of, in which each customer must pay at least a certain sum per mnoth, or, in other words, the system of minimum charge. This method has all the defects of the ordinary system, and the charge will seldom be correct except when it is equal to the minimum charge. If used in conjunction with the discount system, however, it will become much more nearly exact, and has been very successfully

applied in a number of cases. In this latter form, it suggests still another system in which the remaining difficulties have been largely removed, and which it was the principal object of this paper to bring to the attention of central station managers.

As has already been stated, the four chief considerations in determining the proper method of charging for current are simplicty, popularity, precision, and the effect on consumption as a whole. The last two of these will necessarily be the first to be considered, and then the system must, if necessary, be rounded off or altered sufficiently to satisfy the other conditions. Fortunately, however, if precision is attained, the tendency of the current consumption to increase will be consequent for a reason that will presently appear, and it will then only remain to make the system sufficiently simple and popular.

The cost of supplying any customer will depend upon the total number of consumers, his equipment, and his consumption. Obviously then, if the charge is to be correct, it must consist of the sum of his share of each of the three classes of items, plus a certain profit due the operating company. For each customer the A and B expenses remain constant, except as from time to time they are reduced when the business of the company warrants it. Their sum will therefore constitute a base rate which, added to the charge for current, gives a complete solution of the problem from the standpoint of precision. As the base rate through the A items is directly dependent upon the total number of consumers, it will be advantageous to every one to make this number as large as possible. Moreover, the greater the amount of current a consumer uses the less will be the ratio of the base rate to the total charge, and these facts, in conjunction with a precise system, will undoubtedly have a tendency to promote consumption.

It will at once be evident that this is radically different from the system of minimum charge, and its advantages should also be apparent. It is equally simple, more exact, shouid become more popular and reduce the price of electric lighting below that possible with the less precise systems. It shows at once at what figure it will be profitable to accept a doubtful customer, and every consumer becomes a source of revenue proportional to his current consumption, and there is no possibility of its being otherwise. It possesses in common with the system of minimum charge, the disadvantage of being objectionable to a certain class of consumers, but it should be remembered that these are the very ones who, either because they are away a large part of the time or are very small and uncertain consumers, are undesirable customers.

It seems to the writer that the question of popularity will be largely determined by the manner in which this system is applied. Bearing in mind that the chief objectionable feature will be the necessity on the part of each customer of paying his base rate under all circumstances, this charge should be made as small and payments upon it as easy as possible. To do this the company should figure all the A and B items strictly at cost, and profits be made on the sale of current only. When a customer is consuming no current, he can thus remain on the company's books and connected to its service, if he so desires, indefinitely, without being a source of loss, and, on his part, feeling that he is only paying the company what he is actually costing it.

Another way to make this matter appear in a more favorable light will consist in so wording the contract as not to make it appear offensive, and at the same time so that it will convey to the customer's mind the reason and entire fairness of the arrangement. For instance, the following might represent clauses in such a contract:

(3) The subscriber agrees to use current only for the purposes and in the manner and amount above specified, and pay therefor on or before the 10th day of each month, at the rate of —— cents per kilowatt hour, as may be shown by the reading of the meter installed in his premises.

(4) The subscriber further agrees, in consideration of the exceptionally low rates herein above provided, and in accordance with the requirements of the system of charge which renders such rates possible, that he will pay in addition to the charge for current as above specified $—— per year, averaging $—— per month, for the use of the company's apparatus under this contract, and as his share of the fixed operating expenses of the company, which are independent of current consumption. And,

(5) The subscriber further agrees that this fixed charge, or base rate, may at the option of the company be rendered and collected each month, provided that he shall receive the benefit of any reduction which may, during the time he continues to use current, be made to consumers of his class. And,

(6) The subscriber further agrees to give the company —— notice if he should desire to have his service discontinued, and that if at a subsequent time he should again wish to be connected, to pay therefor a sum not exceeding $——.

This last clause is necessary in order to prevent customers ordering the service discontinued during their absence, to avoid the payment of the base rate, when such absence is of brief duration.

In conclusion, it should be noticed that the system is general and applicable to any case. It is more necessary in the smaller stations, for the reason that the load in these is so uncertain and variable. Such special methods as those of Wright or Kapp can be readily introduced, and no change is necessary where there is also a power load upon the station. The various consumers are readily divided into classes depending upon their equipments and the nature of their current requirements, and each class will have its own perfectly definite and fixed base rate. These base rates will of course be the same as the minimum charge in that system. The advantage lies in the fact that this system is much more exact, and for that reason the charge to customers of and above the average size will be materially reduced, becoming, in fact, less than is possible with ony other of the present systems.

FERRARIS AND ARNO'S SYSTEM OF ALTERNATE CURRENT ELECTRIC DISTRIBUTION.[1]

PROFS. G. FERRARIS and R. Arno, of Turin, Italy, have developed a new system of electric distribution of energy with alternate currents, which enables them to supply power, in combination with light, from single-phase alternate current circuits. This device overcomes the troubles of running either lights with polyphase systems or motors with single-phase systems. The new system can also be readily adapted to run motors on existing single-phase circuits, such as are now exclusively used for light. In the new system the general distribution is done with a single-phase alternate current which supplies, in the ordinary way, all the light, but where it is necessary to run electric motors from the main current other alternate currents are drawn off, which have the required voltage and are conveniently shifted in phase so to reproduce in such places a system of multiphase distribution.

The new system of distribution is based on the use of phase-shifting transformers. This name is given to apparatus which, with a given primary current, reproduces a secondary current which, while it has the required voltage and intensity, still has the phase, in a convenient ratio, different from the phase that would exist in the secondary current of an ordinary transformer. These phase-shifting transformers have, like the ordinary transformers, fixed coils, primary and secondary, but they have also an intermediate rotating part whose rotation is maintained like that of an armature of a single-phase synchronous motor.

The working of this apparatus may be explained by considering the performance of an induction motor, for instance, a two-phase motor.

Let us have a two-phase motor made of two coils, AA^1 and BB^1, Fig 1, with the planes at 90 deg., and a short-circuited armature K. If we send into AA^1 and BB^1 two alternate currents with 90 deg. difference in phase, the armature K starts to turn in the same direction of the rotation of the rotary field, resulting from the two alternate magnetic fields produced by the two currents. Vice versa, Professors Ferraris and Arno have demonstrated that if while in one of the two coils is passing an alternate current, for instance in AA^1, we turn the armature K, then in the two coils AA^1 and BB^1 are produced two alternate e. m. f.'s, between which exists a difference of phase of a quarter period, and consequently if the ohmic resistances of the two coils is small, we have also a difference of phase of nearly 90 deg. between the two tensions at the terminals of AA^1 and BB^1. By properly proportioning the number of turns in the two coils we can obtain any ratio between the two e. m. f.'s.

In this way the apparatus represents a transformer in which the coil AA^1 is the primary and BB^1 the secondary. Such a transformer can have, as an ordinary transformer, that ratio of transformation which is desired, but differs from an ordinary transformer as the phases of the e. m. f., voltage and current in the secondary coil differ by a quarter period from the phases that we would obtain, keeping the other conditions the same, from the secondary coil of an ordinary transformer. The armature, once brought up to a convenient speed, will maintain its rotation by the effect of the same alternate current in AA^1 as in an ordinary asynchronous single-phase motor.

In ordinary practice, the phase-shifting transformer will be connected to the circuits as an ordinary transformer, namely, the primary coil AA^1 will be connected to the two

[1] "L'Elettricita."

high-tension primary conductors C and D, and the secondary coil BB[1] to a secondary circuit, R, at low tension. Combining (Fig. 2) this latter circuit, R, of the phase-shifting transformer Tf, with the circuit R of an ordinary transformer, T, we obtain a two-phase system at low tension. In this way the same primary line with single-phase, high tension alternate current can feed single-phase secondary mains at low tension for light, and, where required, two-phase secondary mains at low tension for electric motors.

Fig. 3 gives an illustration of the system adopted to feed

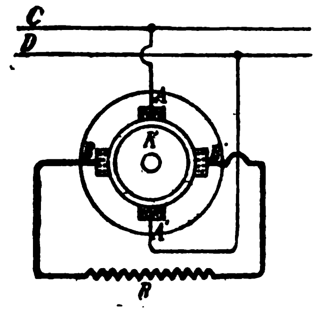


FIG. 1.

two-phase mains: C and D are two primary conductors of an ordinary high-tension alternate current line, TT ordinary alternate current transformers, P and Q the secondary mains distributing the low tension alternate current generated by TT, and Tf is a shifting phase transformer of which the primary coil, AA[1], is connected to the same high tension conductor, C and D, to which are also connected the primary coil aa[1], aa[1], etc., of the ordinary transformer TT.

Connecting two conductors, R and S, to the terminals B and

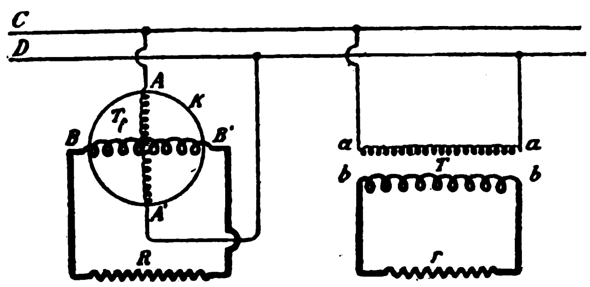


FIG. 2.

B[1] of the coil BB[1] of the shifting phase transformer, the latter will generate and the conductors will carry a current at low tension with the shifted phase to the different points where, besides the lamp L, it is needed to run the motors M. We create in this way different two-phase systems at low tension, with four wires, P and Q, secondaries of ordinary transformers, R and S, secondaries of the shifting phase transformers. Connecting together the point B[1] and b of Fig 2, we save

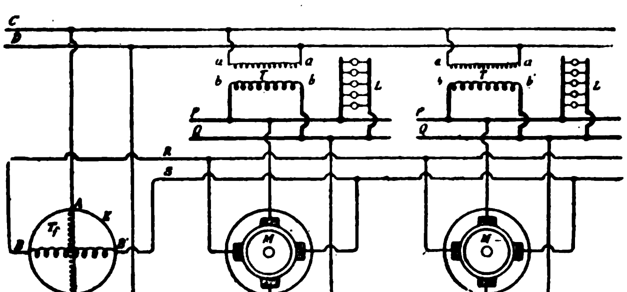


FIG. 3.

one conductor and obtain a three-wire system having two alternate e. m. f.'s, differing in phase by 90 deg.

In an analogous manner, instead of three-wire, two-phase systems, we can obtain three-wire, three-phase systems, using the transformer which shifts the phase by 120 deg., instead of 90 deg. And also higher phase systems can be obtained, increasing the number of wires and introducing different e. m. f.'s conveniently shifted in phase from each other.

Fig. 4 shows an application of the three-wire, two-phase system applied to electric traction. The third wire is represented by the rails, which carry the low tension current from the shifting phase transformer Tf, to start the motors which are also connected to the secondary mains of transformers TTT, supplied by the high-tension feeders C D. The motors, once started, do not require any more current from the third wire as they run, as stated above, like single-phase asynchronous motors. For this special feature, in ordinary practice

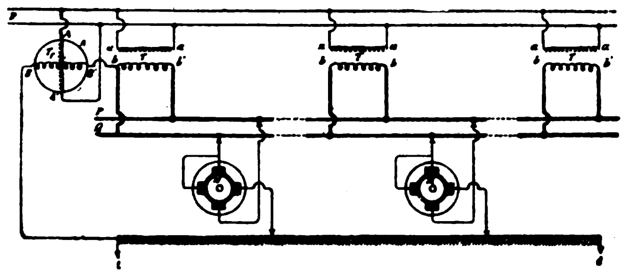


FIG. 4.

the shifting phase transformer and the conductor from it will have a limited capacity, say, large enough to start the biggest motor on the circuit or any number of small motors whose total capacity does not exceed the capacity of the largest motor, and as the large motors will, in practice, be kept running almost continuously, these will not interfere with the running of small motors which will be thrown on and off at the same time, also in large number. When starting large motors a lamp on the circuit, or any other signal or mechanical device, can prevent other motors from being started at the same time, which amounts only to a few seconds.

ON A NEW FORM OF RADIATION.[1]

BY PROF. WILHELM KONRAD RÖNTGEN.

As my investigations will have to be interrupted for several weeks, I propose in the following paper to communicate a few new results.

§ 18. At the time of my first communication it was known to me that X-rays were able to discharge electrified bodies, and I suspected that it was X-rays, not the unaltered cathode rays, which got through his aluminum window, that Lenard had to do with in connection with distant electrified bodies. When I published my researches, however, I decided to wait until I could communicate unexceptional results. Such are only obtainable when one makes the observation in a space which is not only completely protected against the electrostatic influences of the vacuum tube, leading-in wires, induction coil, etc., but which is also protected against the air coming from the vicinity of the discharge apparatus. To this end I made a box of soldered sheet zinc, large enough to receive me and the necessary apparatus, and which, even to an opening which could be closed by a zinc door, was quite airtight. The wall opposite the door was almost covered with lead. Near one of the discharge apparatus placed outside, the lead-covered zinc wall was provided with a slot 4 centimetres wide, and the opening was then hermetically closed with a thin aluminum sheet. Through this window the X-rays could come into the observation-box. I have observed the following phenomena:

(a) Positively or negatively electrified bodies in air are discharged when placed in the path of X-rays, and the more quickly the more powerful the rays. The intensity of the rays was estimated by their effect on a fluorescent screen or on a photographic plate. It is all the same whether the electrified bodies are conductors or insulators. Up to the present I have discovered no specific difference in the behavior of different bodies with regard to the rate of discharge, and the same remark applies to the behavior of positive and negative electricity. Nevertheless, it is not impossible that small differences exist.

(b) If an electrical conductor is surrounded by a solid insulator, such as paraffin, instead of by air, the radiation acts as if the insulating envelope were swept by a flame connected to earth.

(c) If this insulating envelope is closely surrounded by a

[1]Second communication. For the first communication to the Würzburg Physico-Medical Society see The Electrical Engineer, Feb. 12.

conductor connected to earth, which should, like the insulator, be transparent to X-rays, the radiation, with the means at my disposal, apparently no longer acts on the inner electrified conductor.

(d) The observations described in a, b and c tend to show that air traversed by X-rays possesses the property of discharging electrified bodies with which it comes in contact.

(e) If this be really the case, and if, further, the air retains this property for some time after the X-rays have been extinguished, it must be possible to discharge electrified bodies by such air, although the bodies themselves are not in the path of the rays.

It is possible to convince oneself in various ways that this actually happens. I will describe one arrangement, perhaps not the simplest possible. I employed a brass tube, 3 centimetres in diameter and 45 centimetres long. A few centimetres from one end a portion of the tube was cut away and replaced by a thin sheet of aluminum. At the other end an insulated brass ball fastened to a metal rod was led into the tube through an air-tight gland. Between the ball and the closed end of the tube a side tube was soldered on, which could be placed in communication with an aspirator. When the aspirator was worked the brass ball was surrounded by air, which on its way through the tube went past the aluminum window. The distance from the window to the ball was over 20 centimetres. I arranged the tube in the zinc box in such a manner that the X-rays passed through the aluminum window at right angles to the axis of the tube, so that the insulated ball was beyond the reach of the rays in the shadow. The tube and the zinc box were connected together; the ball was connected to a Hankel electroscope. It was seen that a charge (positive or negative) communicated to the ball was not affected by the X-rays so long as the air in the tube was at rest, but that the charge immediately diminished considerably when the aspirator caused the air traversed by the rays to stream past the ball. If the ball by being connected to accumulators was kept at a constant potential, and if air which had been traversed by the rays was sucked through the tube, an electric current was started as if the ball had been connected with the wall of the tube by a bad conductor.

(f) It may be asked in what way the air loses this property communicated to it by the X-rays. Whether it loses it as time goes on, without coming into contact with other bodies, is still doubtful. It is quite certain, on the other hand, that a short disturbance of the air by a body of large surface, which need not be electrified, can render the air inoperative. If one pushes, for example, a sufficiently thick plug of cotton wool so far into the tube that the air which has been traversed by the rays must stream through the cotton wool before it reaches the ball, the charge of the ball remains unchanged when suction is commenced. If the plug is placed right in front of the aluminum window the result is the same as if there were no cotton wool, a proof that dust particles are not the cause of the observed discharge. Wire gauze acts in the same way as cotton wool, but the meshes must be very small and several layers must be placed one over the other if we want the air to be active. If the nets are not connected to earth, as heretofore, but connected to a constant potential source of electricity, I have always observed what I expected; however, these investigations are not concluded.

(g) If the electrified bodies are placed in dry hydrogen instead of air they are equally well discharged. The discharge in hydrogen seems to me somewhat the slower. This observation is not, however, very reliable, on account of the difficulty of securing equally powerful X-rays in successive experiments. The method of filling the apparatus with hydrogen precluded the possibility of the thin layer of air which clings to the surface of the bodies at the commencement playing an appreciable part in connection with the discharge.

(h) In highly-exhausted vessels the discharge of a body in the path of the X-rays takes place far slower—in one case it was, for instance, 70 times slower—than in the same vessels when filled with air or hydrogen at atmospheric pressure.

(i) Experiments on the behavior of a mixture of chlorine and hydrogen, when under the influence of the X-rays, have been commenced.

(j) Finally, I should like to mention that the results of the investigations on the discharging property of the X-rays, in which the influence of the surrounding gases was not taken into account, should be for the most part accepted with reserve.

§ 19. In many cases it is of advantage to put in circuit between the X-ray producer and the Rhumkorff coil a Tesla condenser and transformer. This arrangement has the following advantages: First, the discharge apparatus gets less hot, and there is less probability of it being pierced; secondly, the vacuum lasts longer, at least this was the case with my apparatus, and thirdly, the apparatus produces stronger X-rays. In apparatus which was either not sufficiently or too highly exhausted to allow the Ruhmkorff coil alone to work well, the use of a Tesla transformer was of great advantage.

The question now arises—and I may be permitted to mention it here, though I am at present not in a position to give an answer to it—whether it be possible to generate X-rays by means of a continuous discharge at a constant discharge potential, or whether oscillations of the potential are invariably necessary for their production.

§ 20. In Sec. 13 of my first communication it was stated that X-rays not only originate in glass, but also in aluminum. Continuing my researches in this direction I have found no solid bodies incapable of generating X-rays under the influence of cathode rays. I know of no reason why liquids and gases should not behave in the same way.

Quantitative differences in the behavior of different bodies have, however, revealed themselves. If, for example, we let the cathode rays fall on a plate, one-half consisting of a 0.3 millimetre sheet of platinum and the other half of 1 millimetre sheet of aluminum, a pin-hole photograph of this double plate will show that the sheet of platinum emits a far greater number of X-rays than does the aluminum sheet, this remark applying in either case to the side upon which the cathode rays impinge. From the reverse side of the platinum, however, practically no X-rays are emitted, but from the reverse side of the aluminum a relatively larger number are radiated. It is easy to construct an explanation of this observation, still it is to be recommended that before so doing we should learn a little more about the characteristics of X-rays.

It must be mentioned, however, that this fact has a practical bearing. Judging by my experiments up to now, platinum is the best for generating the most powerful X-rays. I used a few weeks ago, with excellent results, a discharge apparatus in which a concave mirror of aluminum acted as cathode and a sheet of platinum as anode, the platinum being at an angle of 45 deg. to the axis of the mirror and at the center of curvature.

§ 21. The X-rays in this apparatus start from the anode. I conclude from experiments with variously-shaped apparatus that as regards the intensity of the X-rays it is a matter of indifference whether or no the spot at which these rays are generated be the anode. With a special view to researches with alternate currents from a Tesla transformer, a discharge apparatus is being made in which both electrodes are concave aluminum mirrors, their axes being at right angles; at the common center of curvature there is a "cathode ray catching" sheet of platinum. As to the utility of this apparatus I will report further at a later date.

DISTRIBUTION BY ALTERNATING CURRENTS.

We print below an abstract of the interesting discussion of Mr. W. L. R. Emmet's convention paper, on "Results Accomplished in Distribution of Light and Power by Alternating Currents."

Mr. Wagner inquired whether the three-wire, two-phase machine, when operating three wires in place of four, would have 42 per cent. less capacity for lighting. Mr. Emmet replied that such would be the case when operating single-phase instead of two-phase, and drew a diagram on the blackboard, illustrating the point.

Mr. Ayer referred to transformer sub-stations or secondary feeders located at intervals. It was being done abroad considerably, and also in Chicago Mr. Van Trump said he was operating a two-phase system, synchronous motor, driving Edison generators on three-wire system, and the system worked beautifully, with only one exception, which he was unable to explain. That is, with perfectly steady and even load on the Edison generators and no fluctuations whatever in the speed of the generators, there appeared to be a slight fluctuation on the alternating current mains, as though the motors tended to get out of synchronism. They did not pull out of step, however, even on overload. He thought it was due to a difference in the curve of the generator and the motor. It would be so fast that one could hardly notice it at times.

Mr. Emmet thought it was probably due to variation in the speed of the prime mover. A tendency of the prime mover to vary speed would cause a tendency to pull apart; every time the generator varied the least bit in speed, it would tend to pull out, and in doing so would cause a variation in the voltage, and that might take almost any form of vibration. The only remedy was an absolutely uniform speed of generator.

Mr. C. F. Scott, in answer to a question by Mr. De Camp,

stated that large transformers for supplying a number of customers will in general be more economical in the amount of power required for operation and also in the first cost, over the usual plan of supplying each customer by an individual transformer. The capacity of the large transformer may be less than the aggregate capacity of the small transformers which will be required. The cost of secondary mains may be prohibitive, however, if the district is a very large one, or if the service is underground, and the cost of individual connections is high. If the mains must go underground, it would be just as necessary to run the primaries underground with the house connections of the primary mains, which would be more expensive than the secondary mains. This question is one which depends largely on the conditions. In general, he believed in the use of the secondary mains, and believed this would be found the most economical, except in very exceptional cases.

Mr. Scott said that there were one or two points in the paper which he would bring up for general discussion. In a comparison of the three-phase and two-phase systems of distribution, one of the points which confronts the customer is the measurement of the power on the two systems, both commercially for the sale of power and light, and for determining what is going on in the system; the measurement of current in different branches or the measurement of power in different branches. The three-phase sytem is so interconnected that, without elaborate or extended measurements or calculations, it may be impracticable to determine the load on the three circuits, what the relative load is; whereas, on the two-phase system, where the circuits are independent in action, except to a very slight extent, the measurement of what goes on in one circuit—the measurement of the current in one circuit—would indicate the amount of current supplied to the devices connected with that circuit. In general, the amount of power measured directly in one circuit, added to the amount of power measured directly in the other circuit, will give the total power. If the conditions are a little abnormal, or something is wrong, the very time when the ordinary operator wants especially to know where the trouble lies, the two-phase system, with independent circuits, seems to be the best arrangement; and in some cases in practice has given much less trouble to the ordinary electrician than the three-phase system does.

A method of secondary distribution which has not been widely used, but is being introduced, and it seems has a useful future before it, is the three-wire system, with a modification in which only two wires are run from the central station, or in which only two secondary mains may be required, instead of three, which reduces the number of house connections required. In this case a 200-volt circuit might be used as secondary mains, and two connections made to a customer. On the customer's premises, a balancing coil, a coil in the form of a converter, with a single winding, adapted for 200 volts, the two ends of the coil being connected to the 200-volt circuit, and a loop brought out from the middle of the coil, from which point 100 volts may be measured to either of the secondary mains, could be used for the connection of the middle or neutral wire. This coil would serve to preserve a balance between the two circuits, so that, should the number of lamps be greater on one circuit than on the other, the electromotive force would be practically balanced. This simplifies the three-wire system. The loss in balancing coils may be very slight. The balancing coil is a form of converter which will give a very large output, and its capacity need be only that required for the difference in the number of lamps on the two circuits; say there are 25 lamps on one circuit and 75 lamps on the other circuit, the capacity of the coil would be 50 amperes, whereas the total number of lamps on the circuit would be 100. The size of the coil required for this difference in lamps would be the same as would be required for only 25 lamps, if made in the ordinary form of a two-coil converter, so that the cost of these secondary balancing coils need only be quite small.

The system of two-phase distribution shown in Fig. 4 of Mr. Emmet's paper, in which the generator is wound with closed circuit and the terminals brought out at either of four points, two being used for single-phase lighting, and one of the other leads being used in connection with motor work, requires the use of but three wires to any point where motors are required. The use of four wires here is usual in many cases for motors, if the power required by the motors be large. The effective potential of distribution for motors is about 700 volts upon each of the two side circuits, if the lighting be done at 1,000 volts, and the motor be run from three wires; but if all four wires are used, then the effective potential for motor service is 1,000 volts in the transmission line on each of the two circuits. Thus, if the quantity of power to be delivered by the motors is considerable, the use of four wires may lead to a saving in the cost of conductors, making it well worth while to run them. This kind of generator admits of this connection very readily. The only disadvantage of this system that has been pointed out, but is said to be the greatest one, is the reduced capacity of the generator. That point has already been discussed. It is usually satisfactory to the customer to know that he can buy a dynamo for a certain price to do single-phase work, regardless of what the dynamo may do if operated in some other way.

The supplying of motors from a dynamo of this kind by three wires involves the two-phase three-wire system, in connection with which the unbalancing of the two circuits has been pointed out. This unbalancing will tend to unbalance the motor circuits, raising one and lowering the other. This system is best adapted for a large percentage of lighting load, with a motor load as an auxiliary, as is the case in general station practice. In that kind of service the unbalancing of the two circuits does not affect the lighting part, where closeness of electromotive force is required, but affects only the motor work, where the electromotive force is not required to be adjusted with the same nicety. With a motor load, the unbalancing is not quite as great as it is on lighting loads, due to this mutual induction betwen the two circuits. The effect of the unbalancing in the example in the paper is extreme, and results largely from the high frequency of 125 cycles. At low frequencies, the effect would be very greatly lessened.

Mr. Scott desired to reinforce what was said in the latter part of the paper about the flexibility of the alternating system, coming into actual practice. They had heard about the flexibility of this system for a long time; its adaptability to all kinds of service. The example given in the latter part of the paper shows how that is being done now on a large scale, and the Hartford, Conn., plant was one that had come to his attention lately, and he had gone into the details of it. One machine may act as a generator, driven by an engine, supplying power to the city, or it may be run as a generator in multiple with machines at two different stations, ten miles away, or which may be run as a synchronous motor for replacing the engine; this showed a flexibility which ought to find application elsewhere. The running of this current through rotary transformers, for supplying storage batteries, was also an application which ought to be adopted elsewhere. He had heard this plan criticised on one ground, and that was that it did everything, except that the storage batteries did not run back through the rotary transformers and alternating current motor and make steam in the boilers!

Mr. Emmet, referring to the point that Mr. Scott made about the use of compensators, that is, an adjusting device for supplying current to a three-wire system, said that with alternating current we can use such compensators, just as Mr. Scott said; but in practice they would have to be somewhat larger. It might be in certain cases that large compensators are desirable in connection with a three-wire alternating system to help out at some remote point, making it possible to reduce the number of transformers in use in getting over large areas without trouble from unbalancing; but the general distribution of compensators in small units of 10 or 20 lights, such as customers in stores, would seem to be hardly a practicable scheme.

Mr. Dow: I began to use large transformers for 150 to 250 lights in 1889, with entire satisfaction, and found that the very best results could be had; the economy being in first cost, due to the fact that a block where 500 lights were scattered in stores and offices could be served by 250 light transformers, with a reduction of the iron losses. I have had no reason since 1889 to change my mind, and the practice is now to put in the largest transformers we can find; and when the conditions are equal as to cost, and a little against the secondary main, I have found the transformer preferable.

As to the two-phase, three-wire system, I can say from practice that where a large building is wired with the Edison three-wire system, and the neutral is usually of the same size as the two outer wires, in almost every case that system can be used without interference or objection at all from induction or any other trouble. In three cases to my knowledge, in buildings with 600 or 800 lights, we have the Edison three-wire system, and the users did not know the difference. The essential point is that they are not so apt to create a drop in the building. The case is given where the building is wired with the neutral; it is the same size as the outer wires. That method is entirely acceptable, and can be used every time.

I wish to ask: Is there nothing better for series arc light circuits, in connection with the alternating station, than the running of the well-known series dynamos by a motor? Is there no prospect of series alternating arcs, such as might be used for street lighting, assisted by a rectifier system such as is used in England, outside of what is now available up to 50 and 60 light circuits?

Mr. Wagner: Mr. Dow, I think, refers here to a synchronous motor, used to drive counter-shafting, which in turn ope-

rates arc light generators. That could be done in any alternating current station, and the arc machines are operated in that way from the alternating current generators. But it would hardly be an economic way to operate unless it was possible to operate the arc light machines at a distance from the station where steam power could be directly applied. Arc lights can now be operated satisfactorily directly from the alternating current circuits, either using a transformer for each arc lamp or a transformer for a number of arc lamps. I am experimenting in this line, of operating a large number of arc lamps for street lighting from alternating current generators. The system used is one which admits of the use of the ordinary circuits, such as are used for series arc lighting, and with the lamps placed in somewhat the same way. As many lamps as desirable can be operated, I was going to say, but that is limited by the potential. I am now operating as many as 75 lamps on one transformer, and that does not seem to be the limit of the number that can be operated. The system has not been in operation long enough to determine positively its success, and, therefore, I am not quite prepared to furnish all the details. I hope to be able to do so before long; and if it is a success, it will be a very economical way of operating arc lamps in connection with incandescent lighting, by means of alternating current. Arc lighting, incandescent lighting and power can then be furnished from the same generator.

Mr. Ayer inquired whether Mr. Wagner meant to say his system would prove to be economical in a case where 30 per cent. of the station load, as in the case in St. Louis, are arc lights for a large number of hours—several thousand arc lights; whether it would be wise to supply them from the alternating generators, and whether one can introduce stationary transformers in place of direct current transformers, as in the case of driving directly motor generators supplying direct current, or driving existing arc dynamos with motors possibly operated from alternating circuits, or driving directly from the engine.

Mr. Wagner: The point is well taken about the relative proportion of arc and incandescent lighting to be furnished by alternating generators; and as to the economy of so doing I will simply say in answer that it is my firm conviction, which has not yet been proved, that it will be economical to operate not only 30 per cent. of the entire load with arc lamps, but it will be economical where the entire load is arc lamps; but, as I say, that is my opinion. I cannot say it is an established fact.

Mr. Ayer thought the sytem involved serious loss in distribution.

Mr. De Camp asked Mr. Wagner if he had now thrown upon him the responsibility of installing a 1,000-light plant, with arc lamps alone, without any other lighting, whether he would do that installing from, say, four 250-light direct machines, such as we had to-day, or whether he would put in two alternating machines to do it.

Mr. Wagner: I can say that I have taken the responsibility for a larger number of arc lamps than Mr. De Camp mentions, and I cannot say yet whether my head is coming off or not. (Laughter.) It strikes me that Mr. Dow's question might be tersely put by saying, "Is there to be a feasible series of alternating arc lamps?"

Mr. Dow: I have been over this question for four years; I have got to go through it again this fall, the same identical question, with an investment back of it. I have had heretofore to advise the parties interested to put their money into old line machines. I have succeeded in getting higher voltage, greater economy in distribution and great efficiency from the larger machines, but up to the present time I have not found an ideal system. I can answer the question as to the lamps. This present year series alternating arc lamps do work and can be made to work, and alternating lamps can be had which apparently will make just as little trouble as the old line direct lamps. Last year I should have had to say that there was no alternating lamp that could be relied upon and stay in service as long and without complaint as the old style of lamp.

I can throw a little light on the problem concerning rectifiers from recent correspondence with English engineers. The rectifier has been in use in England for four years all told. It began with a 20-light size and has got up to a 60-light size, and there seems to be nothing to prevent its development beyond that limit except the conservatism of the English engineers, who think that 3,000 volts is pretty near the jumping-off place. The efficiency of the device in connection with a first-class alternator, and in its development, is identically the same efficiency that I am getting in my own practice with a 50-kilowatt, 110-volt arc-lighting machine. The efficiency is 73 per cent. from the indicated horse-power through the mains to the output in kilowatts. The output is not in a pulsating current, such as might be had with a rotating coil armature, with a two-part commutator. The light is, to all intents and purposes, a direct current arc, and not the alternating current arc. A series transformer and regulating device gives the same characteristics in the light as arc light dynamos in use in the United States. They have considerable self-regulation. The limiting voltage, as I say, in practice, is 3,000 volts. The limitations appear to be in the commutator. On this side we have succeeded in making commutators operating with 6,000 volts. I do not see why a motor synchronously driven should not operate just as well on the commutator as on a dynamo shaft. I cannot see that there is any difference between the open coil commutator of the well-known types and the rectifier commutator driven by a synchronous motor. The two devices appear to be the same. I look for something in that line and hope to see that same rectifier taken up by some American engineer and experimented with as to its usefulness in alternating transmission over long distances.

The efficiencies I am now getting I believe are as good as the average for public lighting: 8½ per cent. losses in the lines. The lines when fully loaded are more economical, and give 7½ per cent. I believe that is better than the average, and may be considered as a first-class representation of a modern station of that class. I doubt if an alternating system will succeed in increasing that efficiency; and I am afraid that high voltages, 5,000 or 6,000 volts, will be essential in public lighting, as long as the city fathers consider it necessary to have lights in sparsely settled outlying wards.

I have considered as an interesting problem the question of getting down to 3,000 volts; changing from 5,500 to 3,000 volts. I found I should have to double my investment in copper, and that the line losses would, on account of series distribution, be exactly doubled over what they are now, which would be 17 per cent., instead of 8½ per cent. That would be the condition involved in changing from 5,000 to 3,000.

Mr. Ayer: You state that the losses in the distributing system which you experimented with amounted to about 27 per cent. between the indicated horse-power and the output of the machine, with the Ferranti system. What are your losses between your indicated horse-power and your lamps in your regular commercial operation? Mr. Dow answered that, adding to the 73 per cent. at the dynamo terminals, the line losses of 7 per cent., say 66 per cent. would be shown at the lamps. The rectifiers operate at 50 periods per second.

Mr. Emmet drew attention to the fact that constant current apparatus running from alternating circuits must involve the use of a large amount of idle current in the circuit. This, on a large scale, was objectionable, particularly if anything else was operated in the same system. It seemed to be one of the worst limitations of the rectifier system. The frequency at which the rectifier has to operate to go on alternating circuits made it very different from the commutator on an open coil arc machine—for example, a Brush machine. Mr. Dow remarked that the Ferranti machine operated also at 83 p. p. s. Mr. Emmet expressed his doubts as to the commercial practicability of rectifiers on long circuits.

Mr. Wagner remarked that central station managers who were anxious about their heads would do well to stick to well tried systems. Most of his directors had heard from a great many electricians over the country that the system he was trying would not work, and they ought to know. (Laughter.)

Mr. Black: One important point has been left out of the discussion, that is, the efficiency of the alternating current lamp as compared with the direct current lamp. What we want is the maximum amount of light with the minimum amount of power, and in all photometric tests I have seen accounts of, the light derived from the alternating arc has not been more than about 50 to 75 per cent. of that derived from the direct current arc on the same watts dissipated. In that case it seems to me that it is absolutely impossible ever to run commercial arc lights from an alternating system without a rectifier of some description.

ELECTRICAL PHILOSOPHY.

"That was a curious case of Kadger's. He married the eldest daughter of the Bingler family, outlived her, married the next eldest, outlived her also, and then married the youngest."

"Why didn't he begin with the youngest and marry the eldest one last?"

"Well, I suppose he naturally followed the line of least resistance."—Chicago Tribune.

MR. H. C. TOWNSEND, the well-known patent attorney and expert, left for Europe by the New York last week on important business affairs.

THE LIGHT OF THE FUTURE.[1]

BY D. McFARLAN MOORE.

THE lecture was opened by Mr. Moore with a review of the work that has been done heretofore in lighting vacuum tubes having electrodes and incandescent lamp bulbs with various arrangements of filaments, and referred to by him in his paper read at the meeting of the American Institute of Electrical Engineers April 21 and published in The Electrical Engineer of April 29.

After explaining the relations between the kind and quantity of light produced in tubes of different degrees of vacua, and giving a brief description of the vacuum vibrator described in the paper mentioned above, experiments with electrode tubes were described at some length.

If we substitute for a tube with terminals another which is its exact counterpart in form and size, except that it is entirely devoid of electrodes, we will observe after the wire terminals are each wrapped several times around its outside at its ends, that the light is perfectly steady. This feature is of great importance, but it is second to the fact that there is nothing within the tube save the residual gas, and, therefore, its life is almost unlimited. On close examination, both sight and sound tell us that the wires at the end of the tube do not make good contact with the glass, and the slight sparking taking place is detrimental to the volume and steadiness of light. This is cured by painting the outside of the tube at its ends with a thick paint, made by mixing an alcoholic solution with powdered aluminum, and bringing the wire in contact with the paint. A tube has been treated in this manner, and the great increase in the volume of light is apparent. There is no necessity that the two coatings of metallic paint be of the same size; in fact, the one attached to the low potential terminal may be but one-half the size of the high potential coating. If a number of large insulated sheets of metal be connected to an electrode, the light is decreased thereby. Of course the result is the same if it be grounded.

These coatings can be placed at different parts of the tube and connected in a variety of ways to a number of vibrators; but maximum intensity of light occurs when coatings of equal size are placed at the ends of a tube and each connected to a high potential terminal of a vibrator, and the center of the tube attached to the low potential pole. That the light is largely due to the difference of potential, and that polarity is of little importance, can be shown in cases of this kind. The terminals of the tube can both be either high potential positive or both be high potential negative, or one end high potential positive and the other end high potential negative, and the middle terminal can be either low potential positive or negative,, but the tube is equally illuminated throughout its entire length in all cases.

To get the best light from a lamp, the terminal of greatest area must always be negative, irrespective of its potential; with tubes the case is different—that is, to get best light, the largest electrode should be the one of high potential, irrespective of polarity. This fact can be illustrated in the case of tubes with or without electrodes. An electrodeless tube is shown as it appeared under the discharge of a weak current. The apices of the cones of light from each end meet at a fixed point, which remains stationary whether the high potential terminal be positive or negative. With a tube of the same size, but provided with electrodes, the phenomena are the same, except that when the high potential is negative dark spaces appear for a distance of about one-fourth of an inch in front of both of the aluminum discs forming the electrodes; but when the high potential terminal is positive, the dark space appears only in front of the low potential and negative pole.

If three coatings made of tinfoil be insulated with oiled paper and placed one on top of the other at one end of a tube, and each coating connected to a high potential terminal of a vibrator, the light will be but slightly increased over that obtained from the same tube by a vibrator, but not so much as that obtained by three tubes each connected to a vibrator.

The importance of having close fitting metallic caps (best constructed by using a paint of metal powder) covering the glass at the ends of the tubes has already been touched upon. But if the electrical connection between the conductor and the glass is of such importance—and since it is the electrical action of the current on the inside of the glass that agitates the molecules so that they give forth light—the logical interrogation is, What part do the thickness and the composition of the glass play in the production of light?

First, as to thickness. Five tubes were made up, each 1 7-16 inches in diameter and 1 foot 3½ inches long. Tube No. 1 was made throughout of heavy glass, averaging ⅛ inch in thickness. Tube No. 2 was made of thin glass throughout, less than one-thirty-second of an inch in thickness. Tube No. 3 was made of glass of the same thickness as No. 1, except that the glass beneath the caps was as thin as possible; probably less than one-sixty-fourth of an inch. Tube No. 4, the same as No. 1, but provided with two aluminum discs acting as interior electrodes, besides having the exterior caps. Tube No. 5 the same as No. 1, but at its center was blown a bulb over three inches in diameter, causing its walls to be very thin.

Upon trial, no difference was discernible in the volume of light emitted by No. 1 and No. 2, and it was greater than that of No. 3. When the interior electrodes of No. 4 were used alone, the light was very poor, but subject to irregular, brilliant rushes of light with striations. When the exterior caps alone were used, the light was also poor, but steady. Where adjacent caps and discs are connected together striæ seem to find difficulty in formation, but the light is no better. All of these tubes were given the same degree of exhaustion, and were all made of American glass. Two other tubes received the same vacuum and were each 3 feet long and 1¼ inches in diameter; one of American (lead) glass, and the other of German (lime) glass, were tried on the same current vibrator and magnet. The tube of American glass, though it had walls appreciably thicker than the other, gave considerably more light.

The light from a tube 18 inches long by 1¾ inches in diameter of ordinary American glass, but with its ends 3 inches long, made of glass containing a maximum quantity of lead, was considerably less than that from a tube of the same size made entirely of ordinary American glass.

All these experiments go to show that the light is due to electrostatic phenomena. A given rate of vibration may produce maximum light in a lamp made by using a 16 candle-power incandescent bulb, but if an electrodeless tube be substituted for the lamp, it will give its maximum light only after the rate of vibration has been considerably increased. Too high a rate, however (obtained by varying the distance of the vibrator from the magnet core), will diminish the light.

If one end only of a tube be connected to the high potential terminal of the vibrator, the light will be greatest in the end of the tube nearest the cap connected, and if the other end be grounded or grasped in the hand, the light will increase many times. If one end only of a tube be connected to a low potential terminal of a vibrator, it is seldom that any light whatever results.

When two high potential bands are placed at the same end of the tube, but separated from each other, and one or two bands at the other end, an intense light will appear in the small space between the two high potential bands, and the main body of the tube will be almost dark.

An ordinary electrodeless tube connected in the regular manner will light up the instant the circuit is closed, provided the temperature of the room is normal; but if it be cold, five or ten seconds will elapse before light appears. If the tube has been used before, the moment any light at all appears it will be at its maximum; but if it be a new tube that has just been taken from the mercury pump, the light will at first appear cloudy, and will require a minute or two to clear up into an intense white.

Not only the temperature of the interior of the tube and the glass are affected by the current, but also that of the exterior electrode; and when sufficiently high and therefore more conducting, the discharge, evident in the form of light, results. Another way of illustrating how a disruptive discharge is aided by raising the temperature of the glass is shown by attaching a high potential lead to the shell of an incandescent lamp and a low potential lead to a small disc of tinfoil concentric with the top of the lamp. When the circuit is first closed for a moment there is no demonstration whatever; then a single streak of miniature lightning passes from the base of the lamp, a second later quite a number of discharges occur almost together and in a few moments the lamp appears to be encased in a cage of fiery streaks, due to the increased conductivity of the glass on account of its rise in temperature. Although these discharges occur spasmodically, nevertheless each separate discharge appears in the form of a comparatively short but continuous thread of light. I have, however, noted the discharge from a magnet the whole length of which was broken up into short dashes.

If a tube be bent in the form of a circle, care being taken that its ends do not touch, the light is but slightly affected. Also, if an endless tube be constructed with its terminals located at the ends of a diameter, the light is still the same.

An electrodeless tube was constructed 18 inches over all, 1 inch in diameter at the ends, 6 inches at its middle, and was

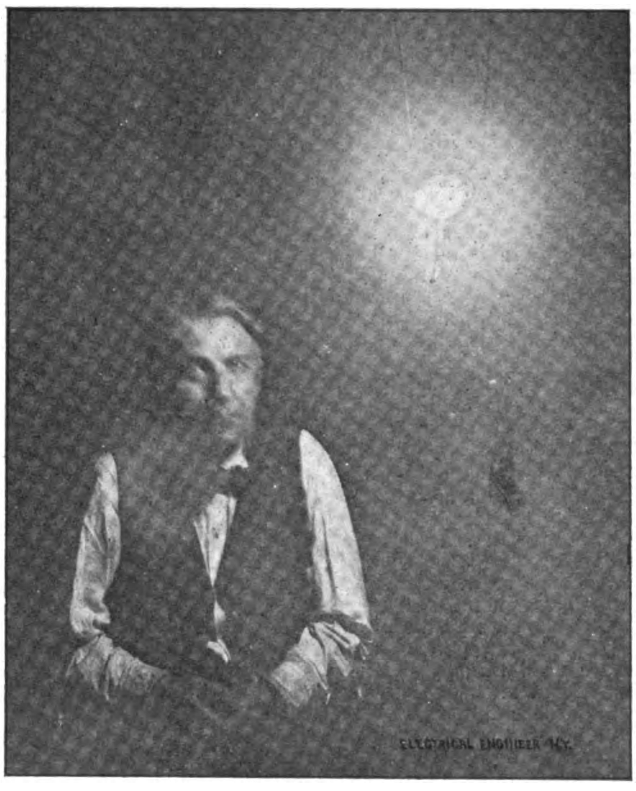
[1] Abstract of a lecture delivered before the National Electric Light Association, May 6, 1896.

one-half inch in diameter, but for 2 inches at the center it was one-quarter inch in diameter. The light was most intense in the center where the diameter of the tube was smallest; less intense in the parts one-half inch in diameter, and least intense at the ends; but the total amount of light given was the same as though the tube had been 1 inch in diameter its entire length, without any contracted portions. Again, the maximum production of light from a tube is directly dependent upon a certain proportion existing between the length and diameter of the tube. To prove this, here is a tube of the same diameter as those that give an excellent light, viz., 1 7-16 inches, but only 5½ inches over all in length and provided with caps 1½ inches long. The light produced is very poor, indeed. There is a tube of fixed dimensions that will give a maximum light for every stated amount of energy.

The problem heretofore has been to get a practical intensity of light from a vacuum tube, regardless of the method pursued or its economy; but since this result, through the agency of the vacuum vibrator, can now be obtained, the main problem has now resolved itself into one of economy. I am happy to say, however, that even here the vacuum vibrator shows an enormous advance over all other methods heretofore used; in fact, from comparative tests between the lighting by incandescence and by tubes of the hall of the A. I. E. E., it was shown that the efficiencies of the two systems do not differ greatly from each other. This is a remarkable statement, in view of the fact that heretofore their efficiencies were almost incomparable; and, secondly, that tube lighting is most decidedly in its embryonic state.

THE EDISON FLUORESCENT LAMP.

DURING the past week Mr. Edison has continued his experiments on his new fluorescent lamp, which, as announced by him in our issue of April 15, is made by fusing tungstate of calcium to the interior of an X-ray tube. When the tube is set at work the entire energy of the X-rays is ab-



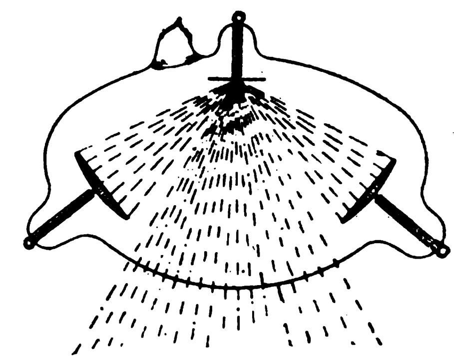
THE EDISON FLUORESCENT LAMP AS IT APPEARS IN MR. EDISON'S LABORATORY.

sorbed by the fluorescent material which emits light. Mr. Edison has found that such a tube shows an entire absence of X-rays externally, and, what is more, no rise in temperature can be detected with a clinical thermometer. Another curious fact noted is that when employed as fluorescent bodies within the tube, instead of outside, as usually employed, some substances develop a higher degree of fluorescence even than tungstate of calcium, which has thus far proved the best. As regards the efficiency of the new lamp, Mr. Edison has made preliminary measurements which seem to indicate a very high economy. Thus, measurements were taken on a lamp which Mr. Edison estimated to be of about 1 candle-power. The measurement was made by placing a Kennelly direct-current ammeter and a Weston direct-current voltmeter in the circuit feeding the primary of the induction coil connected to the lamp. The ammeter showed an average of 2 amperes, and the voltmeter 0.3 volt, which would indicate a consumption of 0.6 watt for the lamp of estimated 1 candle-power. This result is so remarkable that Mr. Edison himself has doubts as to the accuracy of the indications of the instruments, in view of the peculiar nature of the interrupted current obtained in connection with the induction coil. The current in Mr. Edison's experiments is interrupted over 14,000 times per minute. Mr. Edison proposes during the present week to carry out a complete series of accurate photometric and electrical tests with instruments and in a manner which will not be open to question as to their reliability. The accompanying engraving shows the new fluorescent lamp as it appears in Mr. Edison's laboratory. The photograph was taken by the light of the lamp itself with an exposure of about 30 seconds.

FOCUSING TUBE FOR USE WITH ALTERNATE CURRENTS.[1]

BY A. A. CAMPBELL SWINTON.

IN Professor Röntgen's second communication to the Würzburg Physico-Medical Society,[2] he states that he is constructing a special form of vacuum tube for use with alternate currents from a Tesla transformer. For those whose laboratories are supplied with alternating current, but who cannot readily obtain continuous current, a tube suitable for use with Tesla current is an advantage. The annexed illustration shows such a tube which I had made nearly two months ago. The



SWINTON'S ALTERNATE CURRENT X-RAY TUBE.

two curved aluminum discs serve alternately as cathode and anode according to the direction of the current, each focusing its cathode rays upon an identical portion of the flat platinum reflector. If carefully made, so that the foci of the two discs are exactly in the same point, the tube will be found to work well.

By connecting both discs together and using them as cathode, and employing the platinum as anode, the same tube will answer for Ruhmkorff currents.

PHOTOGRAPHS TAKEN IN THE INTERIOR OF CROOKES TUBES.

MR. G. DE METZ has presented a brief paper before the French Academy of Sciences on the above subject. Two photographs were shown which were obtained in the interior of a Crookes tube in a little frame of hard rubber. This frame contained four sheets of sensitive paper and two sheets of Schleussner film of bromide of silver, and was covered first with a sheet of aluminum, 0.33 millimetre thick, and finally by a piece of cardboard, 0.86 millimetre thick. On top of the sensitized layer, but under the cover, a cross of copper was placed. In the first experiment a part of the copper was covered by a sheet of platinum 0.32 millimetre thick, but in the other experiment the cross was left free and in the bottom

[1] London "Electrician."

[2] See page 591 this issue.

of the frame a little shield of zinc was placed. The Crookes tube was of cylindrical form and was composed of two pieces, the parts being fitted together by being ground on emery. The tube carried in one portion the anode in the form of a large ring and the cathode in the form of a spherical mirror, while the other only contained the frame, 29 millimetres in diameter and 11 millimetres high, which was exposed directly to the influence of the cathode rays.

During the operation a Sprengel mercury column was used to examine the degree of the vacuum, when the strong fluorescence of the walls of the glass was obtained. The discharge of the Ruhmkorff coil was made of short duration, from three seconds to two or three minutes, because tne tube quickly became filled with a white glimmer and then the fluorescence became feeble or even disappeared. It was only necessary, however, to pass a few drops of mercury through the pump before commencing the discharge again.

Twelve photographs were obtained. It appears that the cathode rays in the interior of the Crookes tubes have one of the properties of the Röntgen rays, for they penetrated the aluminum, the cardboard, the sensitive paper and the film, but they were arrested by the platinum and the copper.

It is proposed to continue these experiments in the hope of distinguishing between the properties of these two kinds of rays.

PHOTOGRAPHS OF INCANDESCENT LAMP FILAMENTS.

I AM not aware, writes Mr. R. D. Cassells, in the London "Electrician," that experiments have been made to show whether or not certain substances—which in the solid condition at ordinary temperatures are non-transmitters of light—become transmitters of light by increase of temperature, say, to incandescence. Inclosed is a photograph of an incandescent lamp filament, taken by me a few days ago, and photographed by its own light.

The appearance is that where the filament crosses itself in

PHOTOGRAPH OF INCANDESCENT LAMP FILAMENT.

the photo there is a brighter light given out. This would tend to show that the carbon became a transmitter of light when incandescent, so that the light from the rear portion of the filament penetrated the near portion, thus increasing the brilliancy at the points of apparent intersection of the filament with itself. The lamp was run off a 100-volt continuous-current circuit.

FLUOROSCOPE ODDITIES.

Mr. Edison has of late been in receipt of bushels of letters relative to the use of the fluoroscope, and many of them are of an amusing or pathetic nature. In one case, his correspondent wrote from Pottstown, Pa., as follows: "Will you please send me one pound of X-rays, and bill, as soon as possible." In another instance a man with weak sight asked whether he could send his spectacles to Mr. Edison and have them so "fixed up" that they would enable the wearer to see better by means of utilizing the X-rays.

AN X-RAY STUDIO.

Mr. M. F. Martin has opened an X-ray studio at 110 East Twenty-sixth street, where pictures of the interior human structure, etc., will be taken. The consultation hours are from 1 to 2 and 5 to 6. A lady assistant is in attendance.

LETTERS TO THE EDITOR.

MR. FALK ISSUES A CHALLENGE.

IN your issue of May 13, you published a letter written by a man whose identity is well known to me, and, in justice to myself and to the public, I would beg to say that I have never seen in print a more diabolical falsehood. The statements of this man cannot be substantiated.

This man called at my home some six weeks ago, April 13, I believe, and requested me to photograph his hand, to which I consented. I procured the plate. This man then produced a common cardboard box, which he placed at one end of the plateholder which contained the plate. He then placed his hand on the other end of the holder. He then announced that he was ready. I then turned the current on to my tube. The instant I did this he crossed his third and fourth fingers. Can this informant of yours deny that when the plate was developed (which was done in his presence) that the image on the negative showed his hand as he placed it, also the outline of the box which he had placed on the holder in a peculiar position.

The claim that there were some articles in the box is an untruth, for when tnis man picked up this box after the exposure he accidentally let it fall, and it made no other sound than of an empty box. He goes on to say that as I claimed that I used wet plates he opened the holder in the dark and found that I had only an ordinary dry plate. This statement is not worth the paper it is written on, and if you will send a representative of yours to my place, I will prove to him that I do just as I claim, and I defy this man to prove any of the statements he has made in that letter to you, which you have published.

I have challenged this man through the public press (see clippings enclosed), but for reasons best known to himself he did not call to make the test. I will put up $1,000 to every $500 of his that I will photograph his brain in any position he may choose, the position to be unknown to me until he places his head on the plateholder. Let him take this up or shut up.

I intend publishing to the world my method of photographing the brain on the first day of January, 1897. The world will be able then to judge whether I am a fraud or not. This man claims that it is impossible to photograph the brain. He says this because he cannot do it, but it is no reason why others cannot do so.

I hope you will do me the justice of publishing this letter, with one of the clippings of the "Times-Democrat," where I make the offer of turning over to a committee my whole apparatus, with or without my presence.

H. L. FALK,
President X-Ray Shadowgraph Co.

New Orleans, La., May 18, 1896.

As Mr. Falk requests the publication of his letter, as a matter of justice to him, we have complied with his desire. It is needless to say that, notwithstanding Mr. Falk's assertions, our faith in the ability and trustworthiness of the gentleman who made the investigation for us is not shaken in the least. We may add that we have more recently received from Mr. Falk additional X-ray photographs, among them one showing the muscles and arteries of the foot, while another, according to Mr. Falk, shows the kidneys and contiguous organs of Mrs. E. Burke Collins, "the popular authoress of New Orleans." Neither of these photographs shows the slightest trace of bony structure. EDS. E. E.

THE ALUMINUM FLUOROSCOPE.

In the current issue of your review I notice a communication from Mr. H. V. Parsell, Jr., on fluoroscopes.

The irregular luminosity he describes is due solely to the dilation of the pupil of the eye, which, in the darkness of the fluoroscope, is dilated to its utmost. With a view to ascertain the value of his assertion, I have carefully tested both the Aylesworth-Jackson and the aluminum instruments (the latter presented to me by Mr. J. A. Leroy), and I find the aluminum screen to be much more effective, giving greater fluorescence to the transparent, and supershadows in the opaque parts; while the outline of the visible object is sharp and clear. This is certainly what we have sought for, and, as we become more clairvoyant with every revolution of the earth I hope your observing correspondent will take another good, long look through the aluminum.

PROFESSOR O'REILLY,
306 East Eleventh street.

New York City, May 22, 1896.

THE

ELECTRICAL ENGINEER

[INCORPORATED.]

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CONTENTS.

THE SUCCESS OF THE EXPOSITION.

THERE were probably very few who, when the exposition started, had any idea that it would prove such a brilliant success. That it might make a moderate hit, was the expectation of many. Yet even they had their opinions shaken by the pessimistic utterances of those who didn't believe in the success of a technical show anyhow, and who pointed with painful persistence to the undeniable fact that the theatrical and show season in New York this past winter was one of the worst on record. But all hopes and fears alike have vanished before the remarkable and overwhelming demonstration of public interest and popularity, and the exposition thus goes into history as one of the city's red-letter events.

The Exposition Company deserve much credit for their public spirit, and have come out of a severe ordeal with flying colors. Some things might have been better done; other things were better left undone, and yet other things might have been attempted. Granting this, which would be true of any like enterprise, the net result remains in a successful show which has already stimulated the art in a striking manner. Outside the guarantee to the Association of $2,000 for its name and prestige, the company has been run to make money, and not like so many other electrical schemes, to lose it, but the management was very liberal in many ways. Realizing that commercial exhibits alone, however good, would not attract crowds, and desirous that the crowds should come to see those commercial exhibits, the management at the very outset spent large sums of money in building up features of interest and attractiveness, and in giving the show as a whole the setting of ornament and beauty that elicited praise from every visitor.

It is not to be gainsaid that the exposition owed much to Mr. Edison, and that its ability to draw the public was settled the day he generously consented to co-operate. And yet we feel that even he must have been repaid when, upon his first real public appearance, the night of the message around the world, the public yielded to its enthusiastic and wild outburst of applause and would not be stilled. Equally pleasing to him, no doubt, must be the knowledge that by his skill and energy the thousands of visitors were enabled, by means of the fluoroscope exhibit, to test the value of Röntgen's great discovery. The long lines of waiting hundreds were good proof of the way in which to-day a new scientific fact can touch the popular imagination. If there is to be hero worship, it is a good thing for the business to have some of it expended on an electrical inventor; and Mr. Edison has certainly never got so near to the public heart as he did during the past memorable month.

Others, too, with not less public spirit, have given freely of their time and thought and labor, and it is the barest justice to mention Mr. Luther Stieringer, Mr. Max Osterberg, Dr. Park Benjamin, Mr. E. L. Morse and Mr. W. J. Hammer, as loyal, indefatigable workers contributing to achieve so wonderful a success. No exposition could be made a "go" without such effort, and on this occasion it was given without stint.

We have made it our business to inquire among the exhibitors as to how they feel about the results of the show, and have been struck by their unanimity. Satisfaction is a mild word to apply to the feelings of many who have sold large quantities of goods and apparatus and have made hosts of new friends and customers. Several exhibits were sold in block, as they stood, and there was hardly a booth that was not the scene, every night, of inquiries for prices and applications for goods, or agencies. And yet the work was largely educational, for the crowds that are not yet in touch with the art went away deeply impressed with the desirability of enjoying the things they saw and determined to get them in the house, office, store or factory as soon as possible. It is by creating this favorable atmosphere that a market is built up and extended; and New York, with its territory, is a grand arena for such effort at any time. The remark was constantly made at the show that the crowds were largely made up of the very people it was needful to reach, namely, those who represent the wealth, culture, refinement and education of the city. Superintendent Nathan says he had never seen a show where there was such a general wearing of evening dress by the visitors, and that shrewd little comment tells the whole story.

As to the stimulus given to the art, that is as remarkable as the good derived by the industry, and we do not hesitate to say that the National Electrical Exposition of 1896 has carved a deep notch in electrical history. There was, to begin with, the transmission of energy from Niagara, nearly 500 miles, to the little Tesla motor. There was the popular exploitation by Mr. Edison of the Röntgen ray phenomenon. There was the beginning of commercial vacuum tube lighting in the extraordinarily attractive and successful exhibit of Mr. Moore. There was the clever capturing by long distance telephone of the roar of the Niagara cataract and its use as a feature of a great show hundreds of miles away. There was the convincing demonstration of the ease with which aerial motors can haul boats on the Erie Canal. There was the emphatic success of the enclosed arc, and the ocular demonstration of the fact that the storage battery has arrived. There was the proof that the happy union of the electric motor with the tools and apparatus it has to drive is beginning to make a profound impression on all departments of mechanics and engineering. There was a splendid display of beautiful and perfect direct connected dynamos and engines in the generating department, and in the steam section there was one of the most instructive groupings of apparatus and advanced methods that it is possible to imagine. There was, moreover, one of the most interesting of collections of educational and experimental apparatus, including that of Professor Elihu Thomson and Dr. R. Ogden Doremus, as well as that from half a dozen universities and colleges. And when we have enumerated all this, we have left many things unmentioned, any one of which has served, at this great exposition, as a new starting point for endeavor and achievement.

METHODS OF CURRENT CHARGING.

As time passes, methods and apparatus which have proved inefficient in electric light and power distribution are being superseded by more modern devices, and we believe that on the whole American central stations are gradually improving in efficiency of internal operation as well as in those features of general administration in which the distributing company comes in direct contact with the public. But while these improvements have been going on, it would seem that in one very essential feature of administration there has been little progress made even during the last ten years. We refer to the system of charging for current to consumers. In the early days the contract or flat rate was considered adequate, and not its least advantage was its simplicity; but the operating companies soon became aware of the fact that in cases where no fixed number of lights were used for a definite period each day, the contract was a double-edged sword, and that the assumed economic habits of the consumer were but a slender rod to lean on. But far more important, from the standpoint of enlarged station loads, was the deterrent effect which the flat rate exercised on the minds of the public, who preferred to pay only for what they were actually getting. The meter, which, from the beginning, was so strenuously advocated by Mr. Edison, finally won the day, and it is safe to say that no station to-day making any pretence to good management is operating without meters. While a distinct advance is, therefore, noticeable, in this direction, there still remains considerable work to be done to raise the meter system to its highest point of usefulness. It is evident that current for certain kinds of work can be furnished at less rates than for others, that large consumers can be furnished at less cost than small ones, etc., and these conditions have been generally sought to be met by a graded series of discounts. No fault can be found with the basic principle here involved, but it is a question whether its application is generally carried out in a manner best calculated, first, to guard the interest of the central station, and, secondly, with equity to the consumers. It is this question which Mr. A. J. Farnsworth discusses elsewhere in this issue in a manner well calculated to bring out the points involved. We do not believe that any system can be devised that would be perfect enough to embrace all the various conditions that arise in actual practice; but the system advocated by Mr. Farnsworth has the merit of simplicity and unquestioned fairness, up to the limits which it embraces. A perfect system of charging would have to take account not only of the actual energy consumed by the customer, but also of the maximum drawn at any one time, and of similar conditions which have a direct influence on the power equipment at the station. The Wright maximum current indicator has been introduced in connection with a number of English central stations, and with apparent good results. Violent load fluctuations are a source not only of strain on the system, but also of inefficiency in the working apparatus at the central stations, and as such should be taken cognizance of in charging for current. Another point to be considered in charging, which is generally lost sight of, is the time of day at which the consumer draws current. We are well aware that extra rebates are generally allowed to large consumers of current during light load hours, but Mr. Farnsworth has done well to point out that under certain conditions it may be profitable to take on customers at cost or less in order to bring up the load to the point of greatest efficiency for the station apparatus. This particular point is all the more worthy of attention in American central stations, which, with a few exceptions, are still devoid of storage batteries. With the lapse of time, however, it is fair to assume that it will cut less of a figure. Mr. Farnsworth's system of charging, suggested by him in this issue, may well form the text for a general discussion of the subject, and we shall be glad to open our columns to communications with that end in view.

ELECTRIC AND COMPRESSED AIR TRANSMISSION.

The relative advantages and limitations of power transmission by compressed air, as compared with that by electricity, are too well known to require further elucidation at this late day, forming, as they do, the subject of investigations and papers by many able engineers. It is with surprise, therefore, that we note some of the statements contained in a paper by Mr. A. De W. Foote, member of the American Society of Civil Engineers, which appears in the society's "Proceedings" for May. This paper describes the system of compressed air transmission just completed at the North Star Mining Company, Grass Valley, Cal., where between 200 and 300 horsepower are transmitted for a distance of about 1,000 feet. Mr. Foote tells us that electricity naturally suggested itself first as the means to be employed; but visits to mines in operation and careful study and investigation of electrical appliances for underground work, especially pumping, finally decided him in favor of compressed air. His statement would mean primarily that the electrical mining apparatus offered at the present time is not up to the requirements. This is a question involving design, and if such be the case we have little fear that electrical manufacturers can work out their own salvation. But Mr. Foote gives some figures as to the results obtained by the compressed air plant which show that of 304 theoretical horsepower in the water used in the power house, 203 horse-power is actually obtained at the mines, to which must be added the cost of reheating, $3 per day. The efficiency of compression and transmission from the theoretical power of water to and through the motors, including cost of reheating expressed in water power, is put at 61.6 per cent. It is a pity that the author did not give more definite facts and figures to substantiate his assertion of the superiority of compressed air in the present instance, where neither lighting nor railway work is involved, but, assuming his judgment to have been correct, he takes a bold stand indeed when he asserts that, were it 20 miles instead of 1,000 feet, air will prove cheaper in first cost, higher in efficiency, less liable to accident, and less expensive to operate and maintain. To find such an assertion in such a place seems to us to call for some explanation on the part of the author, as he directly challenges the ability and judgment of some of the most prominent engineers of the day. We need only cite Niagara as a case in point. This plant was designed from the very start for power transmission exclusively, lighting work being left entirely out of consideration; and yet an international commission after thoroughly considering all suggested methods of power transmission selected electricity for even the local distribution about Niagara, involving distances scarcely exceeding one and a half miles. But when the author speaks of 20-mile compressed air transmissions as more economical than electric transmission, he sets at naught the experience gained in the last ten years in hundreds of installations. It is quite possible that in the particular case, Mr. Foote mentions, compressed air possessed advantages over electricity, but the broad statement above quoted ought to be backed up by facts and figures—which we think will be hard to produce.

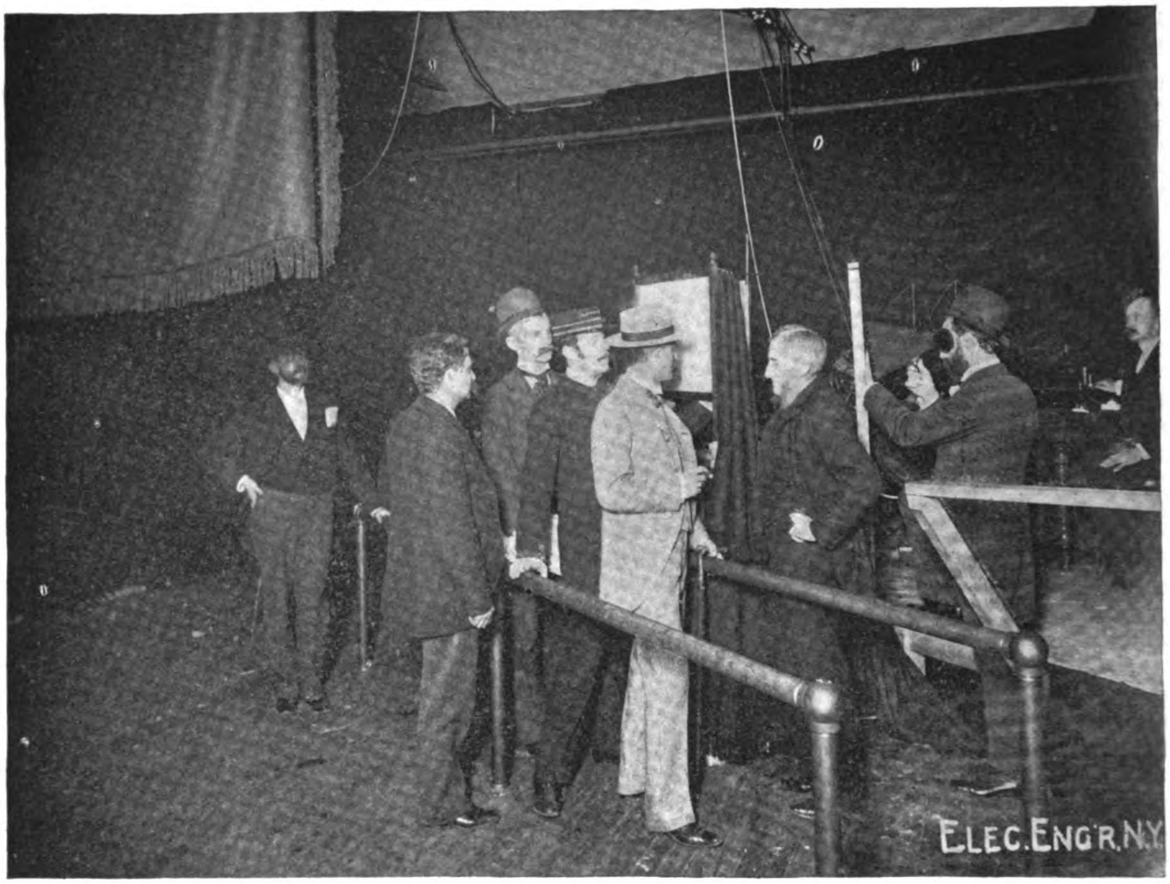
Exhibition Notes—IV.

THE EDISON FLUOROSCOPE EXHIBIT.

WITHOUT doubt, one of the greatest attractions of the wonderful electrical show was the apparatus generously placed at the disposal of the management by Mr. Edison, to enable the public to examine its own anatomy by means of the X-rays. Only those who are at all familiar with the apparatus have any idea of the work and planning that had to be done in order to render successful the task of indulging the curiosity of thousands of people nightly with a personal test of one of the most delicate experiments and most striking discoveries of the age. Mr. Edison early became deeply interested in the trial and himself went through arduous work to get the result that no amount of money could have induced him to undertake. As already stated, it was at first the intention of arranging three or four sets of apparatus, by means of which, using the hand Edison fluoroscope, several people at once could look at their hands. This was experimented with for some time, but it was soon found that it would require a very large expert staff to run such an exhibit, while the risk of breakage of fluoroscopes, failure of tubes, etc., would be multiplied. Such a large staff could not be spared from the laboratory. Work then settled down to the building of a large Edison fluoroscope screen, on which one exhibitor should continuously display his whole arm, but this had its difficulties, and it was also realized that everybody, as a general thing, wanted to see his own bones and not those of some one else.

All this was preliminary to the location and fitting up of the Fluoroscope Exhibit Room, itself quite a distinct and difficult problem, for it involved not only the question of ingress and egress for a steadily flowing crowd, but the choice of the best means for getting the result at the screen. The fact that the thing has proved such an emphatic success is due in no small degree to the expert advice and active personal work of Mr. Luther Stieringer, whom Mr. Edison early called into consultation and to whom he committed the care and operation of the exhibit as a whole. It was decided to locate the room on the third floor, or annex, at the west end, in the rear of the Practical Electrical Laboratory, in such a way that the public could aproach by the long galleries and discharge very appropriately into the restaurant, where it could sit and talk over its experiences.

The room itself was solidly constructed of wood, around some of the iron pillars, the exterior and interior being heavily draped in black, both to exclude light and to accustom the eye to the state in which it would best catch the effect of the Röntgen ray. In this manner a chamber capable of accommodating about 100 people was secured, and the fluoroscope screen, with Crookes tube and Ruhmkorff coil, under the watchful eye of the operator, was placed on the high platform built expressly for the purpose. The visitor entering circuitously, after reading sundry signs instructing him or her to slip a coin or key in the glove, etc., was ushered into the Egyptian darkness, lit only by two blood-red incandescent lamps, the rays of which were intercepted from the fluoroscope by pendant palls of black. Immediately along the edge of the platform ran a stout wooden rail, and outside this was a massive iron rail with stanchions forming an alley through which the endless line of people passed. On coming to the fluoroscope, the visitor was quietly told to slip his hand underneath the supports and press it against the screen palm side toward the eyes, and fingers close together. The hand was thus between the Crookes tube and the screen, and the structure of the hand was immediately visible. So many of the visitors were clumsy, it was early found necessary to stiffen the supports of the fluoroscope and interpose a stout hard rubber slotted shield between the tube and the screen. Even then many people behaved as though they wanted to carry away the whole arrangement on their arms as a souvenir. But the management was excellent, and what with the police outside and the guiding attendants within, things went smoothly every night, and each of some three or four thousand people had a momentary glimpse of their own bony structure —for the first and last time in this life. Many of them flinched when they got in front of the screen and refused to look, either at their own bones or anybody else's. Some crossed themselves devoutly after a fearsome glance, although, as a matter of fact, the great majority came out all smiles and



THE EDISON X-RAY AND FLUOROSCOPE CHAMBER AT THE EXPOSITION.

laughter. No burlesque could be more provocative of merriment than this gloomy room, out of which the visitors emerged very much "stuck on themselves," and poking good-humored fun at the queer look of their friends' bones. The crowd was in reality delighted to find the show neither horrid nor awful. but tickling and mirth-making. There were several who had injuries and deformities. These were sifted out for further study and for experts like Dr. W. J. Morton. The funny remarks made would fill a new volume of Joe Miller.

The mechanism for operating the tubes and screen was placed in an adjoining little room just off the platform and fitted up for the occasion, with a bank of lamps, Root blower for the interrupter, motor fans, etc. Here Mr. Edison was often to be found, and the little "green room," as it came to be called, was the scene of many memorable gatherings of celebrities.

Mr. Stieringer supervised everything and watched every detail, even to such points as placing several fan motors in the dark room and on the stage to keep the crowd and the exhibitors cool. The staff of the exhibit consisted of Messrs. Fred. Ott, C. Brown and C. Dally, three of Mr. Edison's best experts from the "lab." who were at first not a little surprised and amused at their ordeal as showmen, but who soon took to the new occupation with much zest, got lots of fun out of it, as well as hard work, and made their important share in it a brilliant success. It is needless to say that constant care and delicate manipulation on their part were essential, and that at first a daily report of unexpected conditions, to Mr. Edison, was necessary. A Crookes tube is a balky, iniquitous thing, which develops an amazing amount of human depravity and perversity upon a very small margin of vacuum; and to those who watched the performance it was a pretty sight to see how deftly the old tubes were coaxed up to their work or replaced if they gave out, without any holding back of that long, pushing procession of inquisitive New Yorkers eager to be "X-rayed."

In the photograph here shown, the only one for which permission has been granted, Mr. Stieringer is seen at the right taking a shot at the tube with the Edison hand fluoroscope. Mr. Brown, from the laboratory, is at his left. Outside the iron rail stands Mr. Ott. At the extreme right of the picture is Mr. Dally, at the induction coil.

The readiness with which some of the visitors have cried out that the thing was not genuine has had its curious and amusing side. One night a gentleman declined to go inside the rail and said that the screen was only ground glass with a light behind it, an arrangement with which anybody would cast a shadow. It is well known that the range of vision has a good deal to do with the clearness with which the Röntgen ray effect can be seen; and as the fluoroscope is protected by glass the inference was natural to a suspicious mind. Mr. Stieringer seized the man, however, and politely insisted on placing him within the rail, his hand upon the screen and his nose close to the glass. The big bones of the sceptic loomed up with startling vividness, and their owner, with the involuntary ejaculation, "Oh! My God," hastened away with the realizing sense of what modern science could do to confirm the predictions of ancient Scripture as to exposing hidden things.

It is worthy of note before closing this article that Mr. Edison himself operated the fluoroscope exhibit one of the early evenings, to see whether it was all right. He sat by the switch at the coil, and there in the darkness went quietly to work. Perhaps one or two people in the crowd recognized the face and figure when their eyes had become accustomed to the gloom, but it is safe to say that the vast majority had not the faintest idea they were within hand-shaking range of the man who to them represents more than any other the great modern arts of electricity.

THE TELEPHONE AT THE EXPOSITION.

THE exhibit of the Metropolitan Telephone Company was a good illustration of the substantial manner in which the New York telephone service is carried on and of the highly finished appliances used in the telephone service. Realizing the impossibility of adequately representing in an exhibit for a short period the elaborate switchboards and complicated equipment of its central offices, the company decided to install in the exhibition a miniature exchange, placing standard long-distance instruments in the spaces of many exhibitors and generously offering them the free use of the New York service. This was an accommodation that was highly appreciated by the exhibitors, who were thus able to keep constantly in touch with their respective headquarters in and out of the city.

In the space reserved by it the Metropolitan Company placed a small switchboard for operating the exhibitors' telephone lines and four silence booths of various patterns equipped with the different types of standard long distance telephone sets that are supplied to New York subscribers. These are the regular wall set, the desk cabinet set, the wall cabinet set and the desk stand set, all highly finished, substantial apparatus, and forming an interesting demonstration of the enterprise shown in making the subscriber's station harmonize with its surroundings and be an ornamental as well as useful part of the furniture of an office or private apartment.

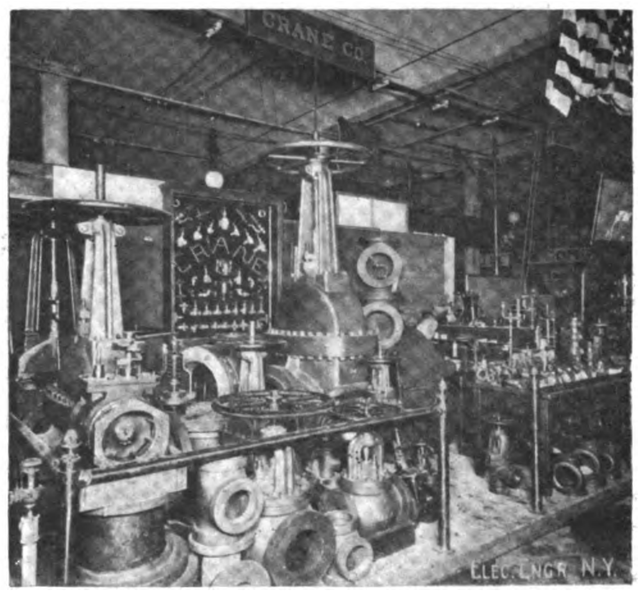
The little switchboard, with its graceful and expert operator, was a constant object of interest to the crowds at the exhibition. It gave them just an inkling of the working of a telephone central, and the rapid play of annunciator shutters, plugs and cords was watched by an absorbed group all day long. If a portion of one of the large multiple switchboards from any one of the dozen exchanges, with an operator doing her daily work putting up connections at the rate of several hundred an hour, could have been shown, it would be the most exciting exhibit in the whole show. The exhibition switchboard had connected to it all the lines to the exhibitors' spaces, those of the four pay-station booths and a number of trunk lines running to the exchange in the Telephone Building on West Thirty-eighth street. Connections were made on it between the exhibitors who wanted to talk with each other and also between any station in the exhibition and any station in the New York system. As might be expected the service was in incessant demand, and the operator and her little switchboard were constantly at work—to the delight of many who probably never knew before what happened at "Central" when they rang their bell and called for a number.

The Metropolitan Company's exhibit proper showed effectively the arrangement of a large public telephone station of which every important hotel in New York has one more or less like it. The company has twelve exchanges in New York, which serve over 15,000 telephones, of which about 1,200 are public stations scattered all over the city. Nearly twice this number are in private residences, this use of the telephone having largely increased during the past year or two in response to the inducements offered by the message rate system, which enables a moderate amount of telephone service to be had at a very low cost.

The exhibit was under the charge of Mr. Brewster. It should be added that the connections for listening to the roar of Niagara were also made through the exhibit and by its staff.

INTERESTING EXHIBIT OF THE CRANE CO.

AN interesting exhibit was made in the Generating Department, on the ground floor, by the well-known Crane Company, of their steam valves and other specialties, in charge of Mr. Fred Mitchell, whose active and intelligent



THE CRANE CO.'S EXHIBIT.

representation of their product made a favorable impression on the many inquirers for data and prices. A view of the exhibit is given herewith. The exhibit consisted of Crane's

extra heavy gate globe and angle valves, and extra heavy fittings for same, from 2½ inches up to 24 inches, inclusive, all having been tested to 800 lbs. pressure and guaranteed to stand a working pressure of 250 lbs. Some idea of the bigness of the work turned out by the company may be formed from the fact that the valve seen in the exhibit weighs no less than 6,770 lbs. These extra heavy valves have been used by the New York Edison Company in their various plants, and also in the two new plants of the West End Railway Company of Boston. Another line shown consisted of Crane's hard metal globe and angle valves, with renewable metallic discs. In addition to these, the exhibit comprised Crane's patent cup check valves, noiseless back pressure valves, pop safety valves, water relief valves, low water alarm, unions with metallic gaskets, Crane's cement, the "Mocking Bird" steam whistles, standard indicator, etc. All the goods shown were of the highest grade of workmanship, while their efficiency and economy is an old story to steam and electrical engineers.

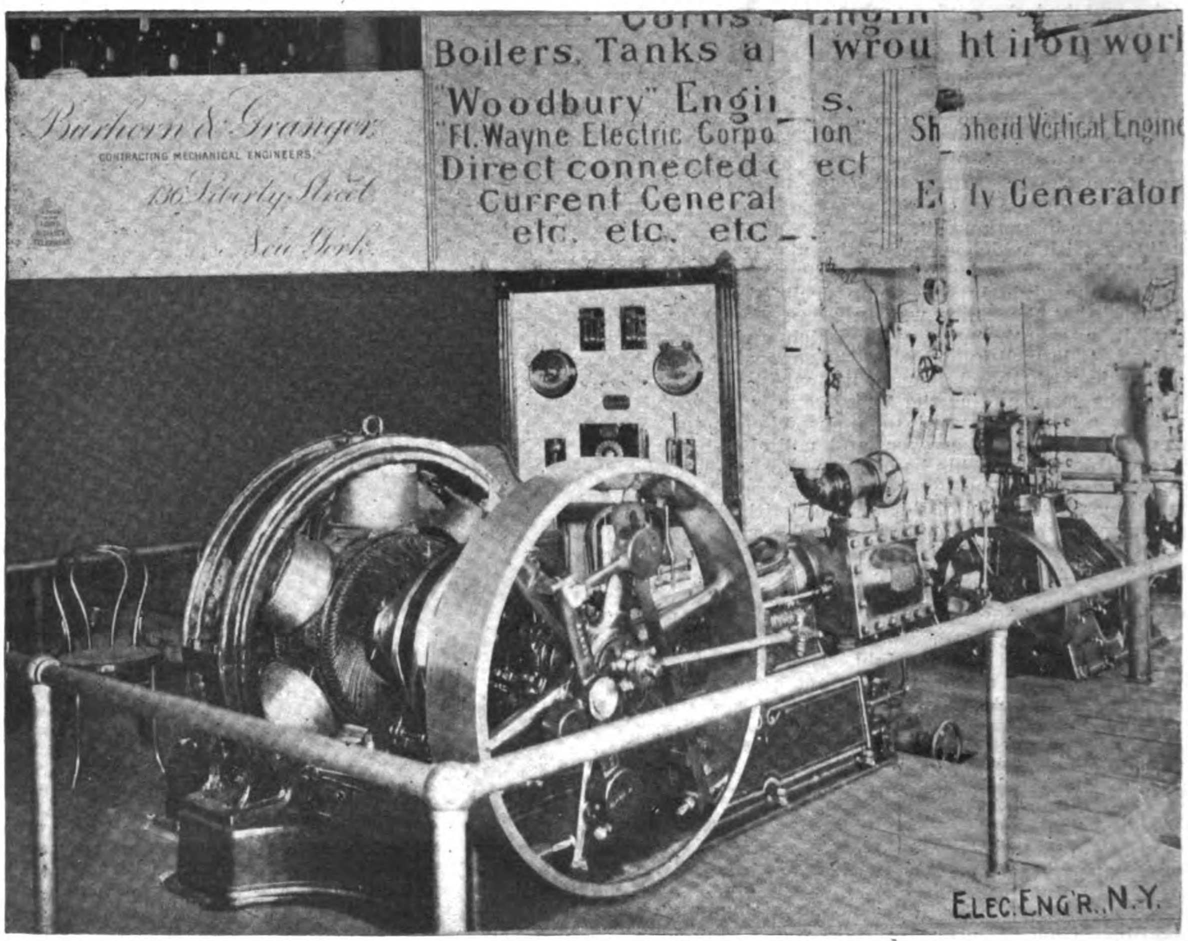
THE BURHORN & GRANGER EXHIBIT.

ONE of the engines that has attracted much attention and favorable comment by engineers visiting the Electrical Exposition is the "Woodbury," exhibited by Messrs. Burhorn & Granger, of No. 136 Liberty street, New York. Not only was the engine seen in operation, running lights and motors continuously, but the design and construction of all its parts were scarring of surfaces, and keeping valve stem tight, even after the engine has been in operation for years, and thereby making the engine most economical in the use of steam; all these were perfectly shown and thoroughly apparent.

The regulation in speed by the governor, under varying loads and steam pressures, was actually shown. A Schaeffer & Budenberg recording tachometer was used to show the speed of the engine at all times, and the entire load of the engine was thrown on and off instantaneously by means of the main dynamo switch. The results obtained were remarkable and excited the admiration of engineers, who watched the test with unusual interest. Under the severest conditions the maximum variation in speed, with all load thrown off or on, was two revolutions, and within a second the governor brought the engine back to its standard speed without racing or vibration. The engine speed being 300 revolutions per minute, the regulation was considerably within 1 per cent.

The Shepherd governor, used exclusively on all Woodbury engines, consists of only two parts, namely, a main arm, containing an eccentric pin; a counterbalance arm, and a flat spring, opposing the governor. The main governor bearing is a roller bearing, and a knife-edge of hardened steel connects the two arms. No lubrication is necessary for the governor, and the latter being entirely frictionless and balanced within itself and in combination with the perfectly balanced valve, it was shown why this regulation should be as perfect as it is.

The engine was not bolted to its foundation, being leveled on six wedges, perfectly free, and ran 300 revolutions per min-



THE WOODBURY ENGINE IN BURHORN & GRANGER'S EXHIBIT.

clearly shown. A cylinder of a standard engine, cut through its center longitudinally, was exhibited, showing clearly the multiple-ported valve, with its quadruple admission and double exhaust ports; the arrangement of balance plate, whereby the perfect freedom from pressure on the valve is obtained, even with the engine running under 125 pounds steam pressure; the easy and absolute freedom from wrecking, due to water in the engine cylinder, and the means of lubricating the valve surfaces before starting up engine, preventing binding and

ute; with a full load coins were balanced on edge on the cross head guides, and water in a glass set on the guides showed not the slightest sign of ripple, showing the remarkably perfect balance in all its parts. With all the surrounding machinery at rest, the "Woodbury" was kept in motion, and the noiselessness of operation was demonstrated. The engine is a 9 x 12 inch, direct connected to a 25 kilowatt Ft. Wayne direct-current generator.

Besides the "Woodbury," Burhorn & Granger showed a 6 x 6

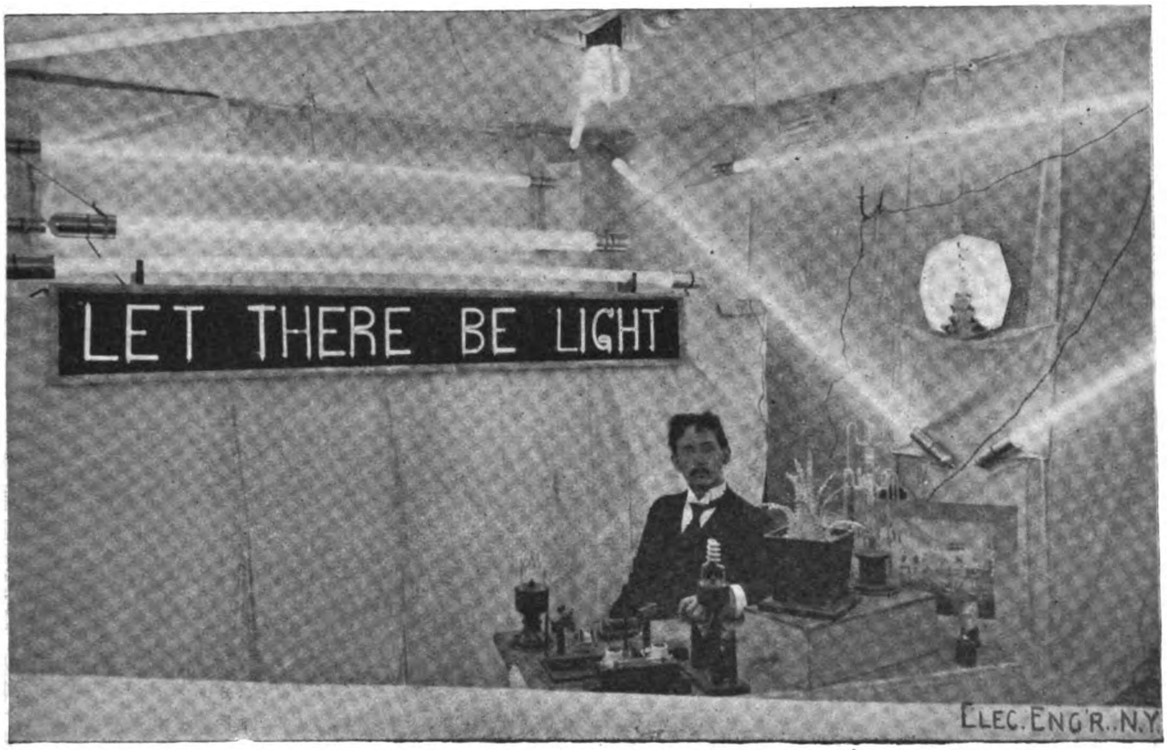
inch Shepherd vertical engine of 18 horse-power, running at 500 revolutions per minute, and connected direct to a 10 kilowatt Eddy generator. This engine has practically the same valve and governor as the "Woodbury," and the regulation is shown to be as close. The engine runs entirely free of noise and vibration, and formed a most unique and instructive exhibit. The entire outfit is to be put to continuous duty at the Metropolitan Apartment House, Eighty-eighth street and Western Boulevard, to carry the day load. Burhorn & Granger are to be congratulated on the completeness and excellence of their exhibit and without doubt, the showing of their engines will leave a decided and favorable impression with the many engineers and others who visited the exhibit.

THE MOORE "CHAMBER OF LIGHT" AT THE ELECTRICAL EXPOSITION.

ONE of the features of the exposition which attracted a stream of visitors, second to no other exhibit, was the Moore "Chamber of Light." Tucked away in a corner at the foot of the gallery stairway, and occupying a space about 10 feet by 12 feet, the Moore exhibit served to attract an average of over 2,500 persons each night. The space allotted to Mr. Moore was economized in the highest degree. The vibrators and the person in charge of the switches were situated behind a screen placed 30 inches from the wall and before which Mr. Moore is seen seated in the accompanying engraving. Running diagonally across one corner of the space a counter was erected, which formed a barrier separating the visitors from the working apparatus. The public was admitted through curtains, a dozen at a time, and each batch was allowed to remain about a minute, and then the fact that their presence was no longer desired was gently conveyed to them by turning out the lights.

The Chamber of Light was lit by about 15 tubes and various ornamental designs, and the sign, "Let There Be Light," which was used on the occasion of the A. I. E. E. meeting and the lecture before the N. E. L. A.

The photograph from which the accompanying engraving was made was taken with an F 32 diaphragm with an exposure of two minutes. A photograph taken with an exposure of 30 seconds showed up almost, if not quite, as well as the other.



THE MOORE CHAMBER OF LIGHT AT THE ELECTRICAL EXPOSITION. TAKEN WITH A TWO-MINUTES' EXPOSURE.

QUEEN & CO., the well-known old house of Philadelphia, were among the leading exhibitors in the annex gallery, where they had a beautiful line of the electrical instruments they handle. It attracted much attention.

THE MORRIS & SALOM ELECTRIC CARRIAGE.

In connection with the exhibit of the Electric Storage Battery Company, the Morris & Salom electric 4-seated carriage was put on view at the Exposition, but it was not treated by any means as a still exhibit. On the contrary, much to the regret of a large number of visitors, who hunted for it, but to the delight of all out-door New York, it was taken into the streets, and put through its paces in a very matter-of-fact manner. Trips were made with it over all the important streets, and many persons had an opportunity of proving for themselves how easily it can be steered and started or stopped. After such a demonstration, New Yorkers will not be very sceptical as to the success of electric carriages.

A SUPPER TO THE EXPOSITION CO.

THAT the exhibitors at the National Electrical Exposition should tender the Exposition Company a supper on the closing night, as an expression of good will, is but another of the many unique features associated with that remarkable affair. The "love feast," organized with much skill and energy by Messrs. G. Stanmore, J. T. Outwater and Frank Harrington, was held at the Murray Hill Hotel, began about midnight and lasted until nearly half-past 2. The Exposition Company was represented by President Smith and by Messrs. Baker, Seely, Peck, Stump, Godfrey, Porter, Nathan and Stadelman. The exhibitors, who were ably represented in every respect, placed Colonel Rogers, of the Brush Electric Company, in the chair, and after supper a few brief congratulatory speeches were exchanged, the speakers being Messrs. Rogers, Smith, Godfrey, Baker, Seely, A. Williams, T. C. Martin, E. P. Morris, Price, Lieb, and McKinney. The supper closed with a rising toast and vote of thanks to Mr. T. A. Edison for the generous manner in which he had helped to make the exposition such a wonderful success, and the names of the other electrical leaders, who had contributed to the art and the success of the show, were also called and applauded.

A COMMENT ON BRUSH DYNAMOS.

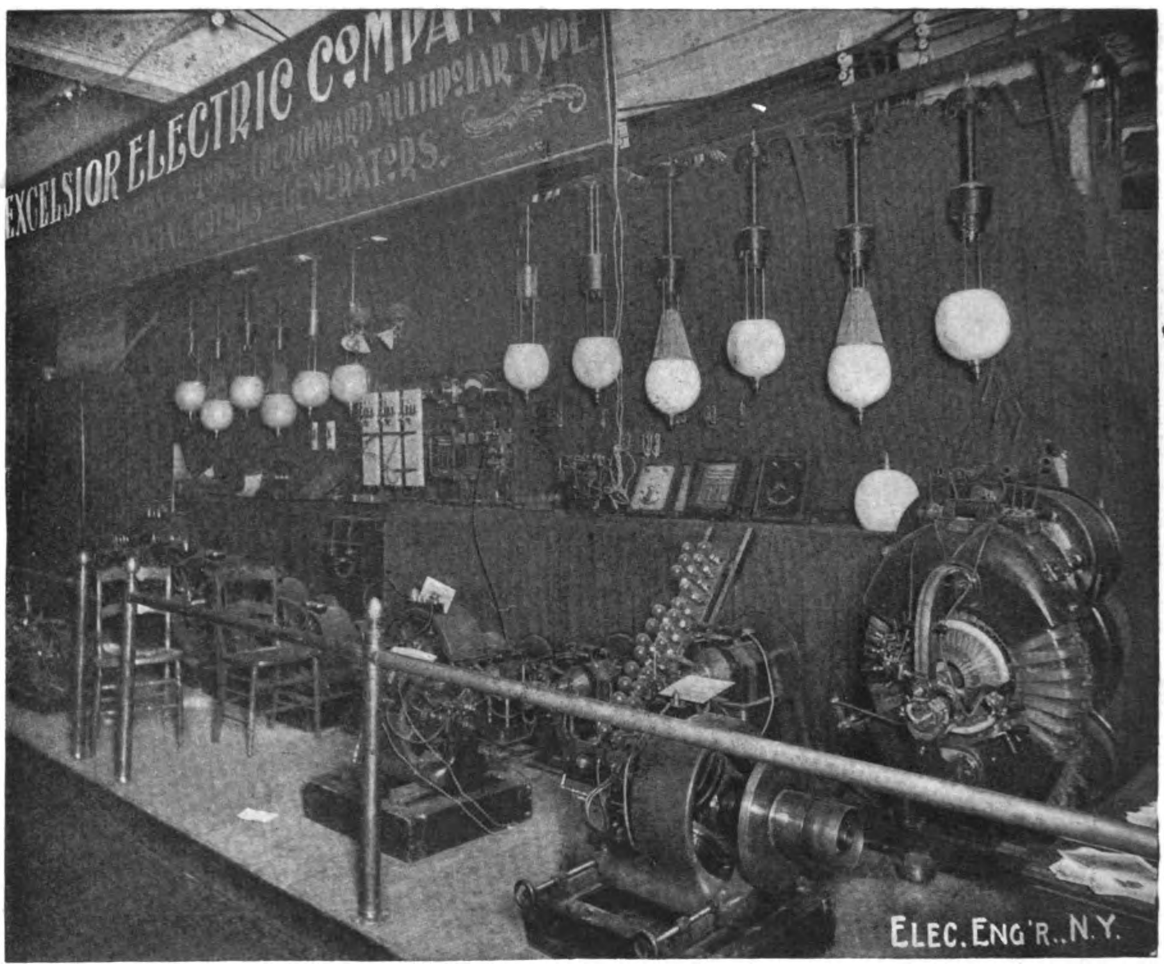
"Sold, but we have others," appeared on a card on one of the large Brush arc light machines that formed part of the exhibit of the Brush Electric Company, of Cleveland. Was any further commentary necessary that electric exhibitions are not only interesting but beneficial and remunerative?

THE FINE EXHIBIT OF THE EXCELSIOR ELECTRIC CO.

ONE of the most striking and creditable exhibits at the National Electrical Exposition was that of the old, well-known and ever progressive Excelsior Electric Company, who, in their neatly arranged space, just off the main floor, grouped together an excellent display of their apparatus for current generation and for lighting and power.

Among the leading features of the exhibit were the latest Hochhausen type of arc machine, capable of carrying 125 lights, and a full line of the familiar and successful Excelsior arc motors ranging from ½ up to 10 horse-power. The leading points about the "big little" arc lighter for 125 lamps are:

(1) Comparatively low shaft speed. This, together with the machine being bipolar, reduces the losses otherwise experienced due to eddy currents and hysteresis. (2) The armature can be taken out and replaced without disconnecting a single wire, by simply loosening two catches. A station equipped with these machines does not need an expensive traveling crane to take out and replace the armatures. (3) Being bipolar and with only one path for the magnetism to flow in, the regulation is absolutely perfect, even under the most exacting conditions, such as a motor load, and in case of an open circuit there will be no perceptible rise in voltage. (4) The regulating motor being directly geared to the rocker arm, the regulation is instantaneous.



THE EXCELSIOR ELECTRIC COMPANY'S EXHIBIT.

Together with this machine was shown a complete line of arc lamps, clutch, rack focusing, low single and double carbon lamps, marble switchboards, lightning arresters, ammeters and wall controllers. This machine was running every night of the exposition on comparatively a short circuit, viz., six lamps. The heating, even under such a severe test, was only just perceptible.

Another section of the exhibit comprised a line of Churchward multipolar generators and motors ranging from 20 lights up to 650, and 1½ horse-power up to 50 horse-power. These machines possess all the features desirable in apparatus of that class, and have ironclad fields, toothed armatures, carbon brushholders, and slow speed. The details of construction are excellent.

The exhibit included also a 7½ horse-power Churchward automatic self-starting, single-phase motor, and an "equalizer" illustrating the equalizer system that was described in The Electrical Engineer of May 13. Supplementary to all this was a full line of patented carbon brushholders used on the above machines, from the little 4 ampere type up to and including the 2,000 ampere; also rheostats, starting boxes, etc. It was a rounded, complete and very interesting exhibit, and the quality of all the apparatus was such as to reflect great credit on the company.

THE McEWEN MFG. CO.

The operative exhibit of the J. H. McEwen Manufacturing Company, installed at the Electrical Exposition, consisting of a 40 kilowatt Thompson-Ryan multipolar generator, direct-connected to a 10 x 10 McEwen engine, received its due share of attention from the engineering profession and others who visited the show.

Its compactness, pleasing outline and smooth running drew many highly complimentary remarks from the thousands of visitors, and in order to satisfy those who were interested from a practical standpoint, a water rheostat was provided so that any desired load, up to 50 per cent. beyond the rated capacity of the dynamo, could be thrown on and off at will. The normal capacity of the dynamo was 320 amperes, at 125 volts, and the test of throwing on and off 450 to 475 amperes instantly with absolutely no sparking and without racing of the engine was a great surprise to all who witnessed the tests.

MESSRS. JOHN G. KLUMPP & SON, wood turners, of 13 Baxter street, New York, distributed an interesting circular in the gallery of the exhibition, calling attention to the goods they manufacture. They are headquarters for wooden push buttons, and a general line of turned wood work for electrical purposes, as displayed in their showcase.

THE BEAUTIFUL EXHIBIT OF THE SAFETY INSULATED WIRE CO.

WE illustrate herewith the magnificent exhibit made at the National Electrical Exposition by the Safety Insulated Wire and Cable Company, under the direction of Mr. Richards, assisted by Mr. Requa, Jr., and Mr. Eckert. The wires and cables used by the management in the equipment of the show were of Safety make.

The display was eminently common-sense and thoroughly forcible from the advertising standpoint, alike attractive to the electrical expert and the unelectrical layman. In passing the exhibit of the Safety Company, when one was just in front there flashed out a sentence in red and black letters on a white ground, the whole frame in quarter oak and standing on an oaken easel. A moment before, the picture was a blank. Before one had finished there was another little picture on the side wall which told a story and disappeared. Then the eye caught a picture which a moment before had been invisible, showing two of the cruisers of our Navy, equipped, as the legend underneath informed the visitor, with "Safety" wire. In front of the entire exhibit, acting at once as a railing and as a sample board, was displayed very handsomely a full line of samples of wire and cable; pieces a foot long were handsomely attached to an oaken slab and then a cross section of each cable was made and deftly inlaid in the oak so that each sample was fully displayed in its outer and inner character. This in itself was interesting, but when to this fact was added another, that many of these were numbered and were referred to in the electric picture signs in front, the interest was doubled.

EXHIBIT OF THE SAFETY INSULATED WIRE AND CABLE CO.

The manner in which the signs flashed in and out was very clever, and it is safe to say that no one passed by who did not stop and spell out slowly, with the motor-driven mechanism, the signs that spoke so bravely and brilliantly of the company's work and success.

EXPOSITION NOTES.

THE S. S. WHITE DENTAL MANUFACTURING COMPANY, of New York, displayed a varied line of their dental outfits operated by Lundell motors.

THE AMERICAN CARBON COMPANY, of Noblesville, Ind., had their line of carbons artistically arranged and displayed in a neat booth on the main floor. Descriptive circulars, which they distributed, dwelt upon the merits of the goods they manufacture.

THE PECKHAM MOTOR TRUCK AND WHEEL COMPANY, of Kingston, N. Y., showed a handsome truck for a four-wheel electric car, but had no one in attendance, evidently believing that a sample of their celebrated goods speaks for itself, in the excellence of its workmanship.

L. S. BEARDSLEY, Naugatuck, Conn., had a unique display of his manufactures in the gallery of the exposition. Mounted on a wooden frame were two wooden cross arms, to which were adjusted his iron brackets, tridents, etc., for attaching telegraph, telephone and trolley wires. Mr. Beardsley's work showed solidity and excellent workmanship.

FAYERWEATHER & LADEW, 30 Spruce street, New York, had an imposing array of leather belting at their booth on the floor of the generating exhibit. Large double and three-ply belts, single and dynamo belts, twist belting, all of pure oak tanned leather, also rawhide lace leather, give the prospective buyer an excellent idea of the line of superior stock this well-known firm have to offer.

THE CROWN WOVEN WIRE BRUSH COMPANY, of Salem, Mass., had an interesting exhibit of their well-known woven wire brushes for dynamo and motor use, in conjunction with the exhibit of H. B. Coho & Co., who are their New York agents. These brushes are becoming more popular every day, as they are made from the finest quality of soft copper, and are extremely easy on commutators.

THE WESTERN TELEPHONE CONSTRUCTION COMPANY, of Chicago, occupied two spacious booths, one on each side of the entrance on the main floor, so that each stream of visitors as it entered saw their apparatus at once. The display was very interesting and comprised telephone switchboards, long-distance telephones, power generators, and desk sets of various styles; also police and fire alarm systems.

THE J. G. BRILL COMPANY, of Philadelphia, were represented at the exposition by Mr. George M. Hackell, and had on exhibition one of their famous 21 F Standard Broadway trucks. Their exhibit was surrounded by a few printed signs, bearing interesting information regarding the success of the Brill truck, one of them stating that more than 14,000 Brill trucks of the different styles have been supplied to American electric railroads.

THE TUCKER ELECTRICAL CONSTRUCTION COMPANY, of New York, were conveniently housed in a snug booth on the main floor of the exhibition building. Their display comprised interior intercommunicating telephone systems, hotel telephone, factory and private line systems, an interesting novelty also in connection with their exhibit being a desk light which can be attached to any pigeon hole in a roll-top desk. Mr. Wm. A. Moore had charge of the exhibit.

THE FOSTER ENGINEERING COMPANY, of Newark, N. J., regulated the steam pressure of the entire generating plant of the exposition with their efficient pressure regulator and reducing valve. This well-known company also supplied the reducing valves used on the engine operating the automatic stoker, coal conveyor and steam blower, connected with the Root boilers. In addition to these, the Foster Company exhibited their new automatic safety stop valve, designed as a

life and property saver in mines, collieries, on shipboard and in boiler rooms of large steam plants.

THE BRIDGEPORT CAR EQUIPMENT COMPANY, of Bridgeport, Conn., had a very interesting electric third rail exhibit. It consisted in a model of a top rail depressed into contact with a live rail underneath it and which was inclosed in a flexible water-tight steel tube. This system is adapted for both street and steam roads, the former requiring but the removal of a paving block. It is inclosed by protection plates which come together, and form a slot over the depressible rail. The steam road is shown as in a freight yard, overcoming the switching problem. This company claim a large saving in the use of their system.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS ISSUED MAY 19, 1896.

Alarms and Signals:—

BLOCK SIGNAL SYSTEM. A. L. Creelman, Chicago, Ill., 560,193. Filed Dec. 21, 1894.
Consists in operating signals by electromagnetic devices actuated by the current from a main power wire, the action of said devices being controlled by a local circuit containing suitable circuit controllers adapted to be operated by the passing train.

CIRCUIT FOR LATENT SIGNAL TRANSMITTER. F. B. Herzog, New York, 560,212. Filed Feb. 14, 1895.
A normally open circuit signal transmitting mechanism at one station; a circuit closer closing said circuit by the act of preparing said transmitter to transmit its signal, and means, on another circuit, for controlling the operation of said signal transmitter.

TRAIN SIGNAL. W. Biddle, Brooklyn, N. Y., 560,293. Filed March 22, 1894.
Comprises a rolling signal upon an armature lever, two electromagnets for giving motion to the armature lever and to the signal, a circuit closer operated by the armature lever, and electric circuit connections to the central station for indicating the movements of the respective signals automatically.

ELECTRICAL ANNUNCIATOR. G. J. King, Oakland, Cal., 560,358. Filed Nov. 21, 1895.
For hotel use.

DEVICE FOR RAILWAY SIGNALING OR OTHER PURPOSES. M. B. Leonard, Richmond, Va., 650,359. Filed Feb. 5, 1895.
Circuit closer is operated by wheel of passing car.

ELECTRICAL APPARATUS AND SYSTEM. M. B. Leonard, Richmond, Va., 560,360. Filed Feb. 19, 1895.
A block signal system.

ELECTRIC BLOCK SIGNAL AND TRAIN LIGHTING SYSTEM. J. C. West, Atlanta, Ga., 560,451. Filed Dec. 23, 1893.
Consists in mechanism for automatically cutting off the steam of two oppositely moving locomotives and for applying the airbrakes thereof when said locomotives enter the same block.

ELECTRIC BELL. F. and H. F. Keil, New York, 560,506. Filed Dec. 16, 1895.
The combination of the armature with the angular pivoted spring, having the tongue and loop separated at their ends and the bifurcated stud receiving said tongue and loop.

ELECTRIC SIGNALING APPARATUS AND SYSTEM. M. B. Leonard, Richmond, Va., 560,619. Filed Nov. 10, 1894.
Block signal system.

Storage Batteries:—

CONNECTION OF STORAGE BATTERIES. R. McA. Lloyd, New York, 560,272. Filed Nov. 16, 1895.
A secondary battery element having a projection and engaging the mercury, a copper connector secured to the projection and engaging the mercury and provided with a band of enamel between the projection and mercury contact.

Dynamos and Motors:—

DYNAMO ELECTRIC MACHINE. R. Schorch, Darmstadt, Germany, 560,328. Filed Dec. 14, 1893.
Embodies an open coil armature.

ELECTRIC MOTOR FAN. J. D. Brinser, Lancaster, Pa., 560,569. Filed July 12, 1894.
Details relating to a ceiling fan.

ALTERNATING ELECTRIC MOTOR. R. Lundell, Brooklyn, N. Y., 560,591. Filed Feb. 18, 1895.
An alternating electric motor having field magnet coils and a short-circuited armature, with additional armature coils having circuit connection with a source of current supply adapted to generate currents of low voltage, the field magnet coil being connected directly to the current mains.

Electro-Metallurgy:—

MAGNETIC SEPARATOR. F. J. Barnard, Seattle, Wash., 560,184. Filed Sept. 10, 1895.
Consists of a series of magnets or a magnetized plate located above a non-magnetic base or conveyor plate, which is reciprocated by suitable means over a sluice.

ELECTRICAL FURNACE. E. G. Acheson, Monongahela City, Pa., 560,291. Filed June 25, 1894.
For the production of silicide of carbon.

MANUFACTURE OF METALLIC ARTICLES BY ELECTROLYSIS. M. Perreur-Lloyd, Paris, France, 560,533. Filed Sept. 26, 1895.
Consists in applying to the slight roughness on the surface of the cathode a very thin coating of fatty matter.

Lamps and Appurtenances:—

HANGER FOR ELECTRIC ARC LAMPS. T. H. Brady, New Britain, Conn., 560,255. Filed Jan. 4, 1896.
Consists of a pair of dependent hooks with hollow bases, in each of which is seated a spring extending across the mouth of hook, said spring being provided with a hole to fit over point of hook.

HEAD BLOCK FOR ARC LAMPS. A. N. Edeburn, Cleveland, O., 560,262. Filed Aug. 12, 1895.
Details of construction.

ELECTRIC ARC LAMP. E. J. Bagnall, Cleveland, O., 560,387. Filed Dec. 14, 1895.
The combination with the separating and feeding magnet of an alternating current arc lamp and the carbons, of an armature lever connected directly with the carbons, a retarder and a spring forming the sole connection between said armature lever and the retarder.

ELECTRIC ARC LAMP. J. McLaughlin, Chicago, Ill., 560,421. Filed May 15, 1893.
The current from the line is cut out and directed about the arc of the lamp when from any cause a lamp so cut out has become inoperative.

ELECTRIC ARC LAMP. C. L. Coffin, Detroit, Mich., 560,476. Filed March 13, 1894.
The arc is subjected to the influence of a magnet in which the lines of the field of force are substantially parallel with the current producing said arc.

Measurement:—

ELECTRIC MEASURING INSTRUMENT. E. Thomson, Swampscott, Mass., 560,379. Filed March 29, 1895.
The combination of fixed members composed of coils and a movable member also composed of coils, the coils being disposed and wound so as to balance the movable member astatically in the magnetic field.

Miscellaneous:—

ELECTRIC IGNITER FOR GAS LIGHTING. W. F. Rudolph, Philadelphia, Pa., 560,284. Filed Sept. 6, 1895.
Details of construction.

ELECTRICALLY ACTUATED DENTAL PLUGGER. J. W. Gilbert, Philadelphia, Pa., 560,315. Filed Nov. 7, 1895.
The supporting frame consisting of the two parallel tubes serving, respectively, to receive the plugger handle and as a housing for the spring of the armature hammer, and the end pieces with which said tubes are connected.

ELECTRIC IGNITER FOR GAS LIGHTING. W. F. Rudolph, Philadelphia, Pa., 560,370. Filed Nov. 29, 1895.
Details of construction.

PROCESS OF AND APPARATUS FOR BLEACHING VEGETABLE FIBERS. C. Kellner, Vienna, Austria-Hungary, 560,411. Filed Dec. 5, 1891.
Comprises a pair of bleaching tanks, an electrolyzer having its positive cells connected with one of said tanks and its negative cells with the other, a reservoir common to both tanks, a revoluble stirrer contained in the reservoir, and a pump for pumping the liquid flowing into the reservoir from said tanks back to the electrolyzer.

TREATMENT OF SODIUM CHLORID. J. Meyruels, Paris, France, 560,518. Filed July 24, 1893.
Method of manufacturing chlorine, white lead and bicarbonate of soda.

SALES INDICATOR AND ALARM. C. F. Davis, Missoula, Mont., 560,194. Filed March 3, 1895.
The combination of the series of indicators, means for actuating any desired one of said indicators, with an alarm and connections for operating said alarm whenever any one of said indicators has been operated a fixed number of times.

COIN-CONTROLLED ELECTRICAL APPARATUS. J. N. Peirce, Boston, Mass., 560,423. Filed Feb. 19, 1896.
A coin displaces a detent causing release of the current closing arm.

TYPEWRITING MACHINE. G. H. Davis, Washington, D. C., 560,572. Filed Oct. 2, 1894.
An electrically connected supporting frame suitably hinged in front typewriter frame, a hinged keyboard located above the supporting frame, and a series of electrically connected keys carried by the keyboard.

TYPEWRITING MACHINE. G. H. Davis, New York, 560.573. Filed Nov. 15, 1894. Similar to above.

Railways and Appliances:—

ELECTRIC RAILWAY SYSTEM. J. C. Henry, Westfield, N. J., 560,265. Filed Nov. 26, 1895.
A system whereby the advantage of the "three-wire system" may be availed of and at the same time the potential on different parts of the line may be kept at different voltages.

ELECTRIC RAILWAY. N. Leidgen, Milwaukee, Wis., 560,269. Filed March 11, 1895.
Comprises a hanger having curved sides for receiving the ends of the wire sections, said sides terminating in upwardly inclined cam surfaces and weighted eccentrics pivoted to said hanger for clamping the ends of the wires against said curved sides.

METHOD OF ATTACHING RAIL BONDS TO RAILS OF ELECTRIC RAILROADS. D. W. Payne, Elmira, N. Y., 560,366. Filed Aug. 24, 1895.
The bonds are welded directly to the rails.

POWER GEARING FOR ELECTRIC CARS. E. A. Sperry, Cleveland, O., 560,375. Filed June 6, 1894.
A yielding coupling forming part of power driving, and a casing inclosing said yielding coupling, said casing being integral with the journal bearing of the power driving connection.

ELECTRIC BRAKE. W. B. Potter, Schenectady, N. Y., 560,428. Filed Feb. 3, 1896.
Reverses the relation of armature and field so that they act as generators.

ELECTRIC RAILWAY SYSTEM. G. Westinghouse, Jr., Pittsburg, Pa., 560,452. Filed July 27, 1895.
A circuit closing switch for electric railways, an armature and contact plates and loosely mounted support therefor, provided with downwardly projecting pins or lugs, and a spring on which said pins or lugs rest.

RAIL BOND FOR ELECTRIC RAILWAYS. H. W. Wyman and F. H. Daniels, Worcester, Mass., 560,455. Filed June 26, 1895.
A rail bond having the terminals or ends made integral with the body of the bond and of much larger diameter.

ELECTRIC RAILWAY SWITCH AND BOX THEREFOR. W. Chapman, Washington, D. C., 560,471. Filed July 29, 1895.
A bottom comprising a horizontal base plate, a peripheral flange projecting above said base plate and two concentric flanges below said base plate joined at their lower edges to form a trough or channel.

CURRENT COLLECTING DEVICE FOR ELECTRIC RAILWAYS. W. Chapman and P. W. Davies, Washington, D. C., 560,472. Filed July 29, 1895.
The combination with a car truck and jointed collecting bars, of a supplemental truck for guiding said collecting bars.

ELECTRIC RAILWAY. W. Chapman, Washington, D. C., 560,473. Filed Aug. 1, 1895.
A contact bar, supported, consisting of a plurality of conducting

lengths or sections insulated from each other, with means for cutting either or both of the end sections into and out of circuit.

ELECTRIC RAILWAY. R. Lundell, Brooklyn, N. Y., 560,513. Filed Dec. 6, 1895.

Comprises a current feeder or main, two rows of sectional trolley conductors, permanently interconnected electromagnetic switching devices in combination with a return conductor or rail located between said rows of sectional trolley conductors.

ELECTRIC RAILWAY SYSTEM. D. MacL. Therrell, Charleston, S. C., 560,551. Filed Jan. 9, 1896.

A magnetized shoe is suspended from the car, a ball-bearing device upon the shoe carrying balls of non-magnetic material of good electrical conductivity.

Switches, Cut-Outs etc:—

ELECTROMAGNETIC DASH POT. J. D. Ihlder, Yonkers, N. Y., 560,216. Filed Feb. 8, 1895.

Adapted to be used in connection with electric elevators.

ELECTRIC AUTOMATIC STOP FOR ELEVATORS. J. D. Ihlder, Yonkers, N. Y., 560,217. Filed July 27, 1895.

The combination with an electric motor and a short circuit therefor, of a switch controlling said circuit, and an automatic stop device controlling said switch.

SHUNT CIRCUIT WATER RHEOSTAT. J. Buchel, New Orleans, La., 560,340. Filed Dec. 7, 1894.

Comprises a receptacle containing a liquid, the main circuit plates therein, the shunt circuit plates also immersed in the liquid, the relative positions of the two sets of plates being adjusted.

CIRCUIT BREAKER. W. B. Potter, Schenectady, N. Y., 560,427. Filed Jan. 18, 1896.

Adapted for use on drawbridges.

SAFETY DEVICE FOR ELECTRIC MOTORS. J. D. Ihlder, New York, 560,503. Filed Sept. 12, 1892.

Comprises a duplex shunt circuit of relatively high resistance, including two parts of a magnet-coil, and a safety device arranged in said duplex shunt circuit.

ELECTRIC RHEOSTAT OR HEATER. H. W. Leonard, East Orange, N. J., 560,588. Filed March 20, 1896.

A ribbon-like conductor attached to a large mass of material, having a high specific capacity for heat and insulated therefrom by a minimum thickness of insulating material.

Telegraphs:—

POLAR RELAY. T. B. Dixon, Henderson, Ky., 560,313. Filed March 27, 1896.

Means for preventing polar instruments from being influenced by false currents in the line.

Telephones:—

SWITCHBOARD. D. M. Munro, Gaithersburg, Md., 560,275. Filed Feb. 26, 1896.

Connections between any number of subscribers may be made by sliding out or in a single switch plug.

TELEPHONE RECEIVER. S. D. Field, Stockbridge, Mass., 560,403. Filed Aug. 24, 1895.

In combination with the diaphragm, permanent magnet, and polepiece of soft iron, two equal, reversely acting helices, serially connected in a circuit, one of said helices being nearer the polar extremity of the core than the other.

TELEPHONE SIGNAL AND SIGNALING CIRCUIT. A. de Khotinsky, Boston, Mass., 560,617. Filed March 13, 1896.

Employs the same battery for call signals, for conversation and the operation of disconnecting signals.

MISCELLANEOUS.

THE GREAT STORM IN ST. LOUIS.

THE city of St. Louis was visited last week by a terrific tornado, which devastated also the adjoining town of East St. Louis and the surrounding country. Hundreds of lives were lost, many people were injured, and the destruction of property is said to have reached $50,000,000. All the trolley car systems were terribly crippled by the breakage of their lines, and the damage to cars and power plants.

The Missouri Electric Light and Power Company escaped damage to the power house, but in many places the wires and a great many of its poles went down. The estimate of poles down reaches 500. The company has sufficient reserve supplies on hand to repair its loss, and 200 linemen at work, but fully three or four weeks will elapse before all connections are made.

With the Edison Company the poles and wires in about 200 blocks from the levee to Grant avenue and from Rutgers to Clark avenue were torn down, and every arc lamp was smashed. The power house was a wreck, although the machinery was not greatly injured.

Expert electricians and linemen and even laborers were imported from neighboring cities in large numbers to reconstruct the broken telephone, telegraph, and electric light lines. Car loads of telegraph poles, wiring, and lamps and various electrical apparatus are arriving, and with the stocks constantly carried by the various companies furnish material for thousands of workmen. The Bell Telephone Company's wires along the track of the storm are a total loss. The company carries a heavy supply, and was enabled to start 500 men at work. A conservative estimate of the company's loss is $75,000.

The Postal Telegraph Company lost only about $4,000, their damage being of such a nature that it is easily repaired.

The Western Union had 300 men in East St. Louis last week untangling wreckage preparatory to repairing wires. The extent of the loss the officials cannot yet estimate.

The Wagner Electric Manufacturing Company telegraph us that they escaped entirely the effect of the storm; that no delay will be experienced at their factory, and that all orders will be filled as per contract. They are naturally very busy at this time, but have splendid facilities.

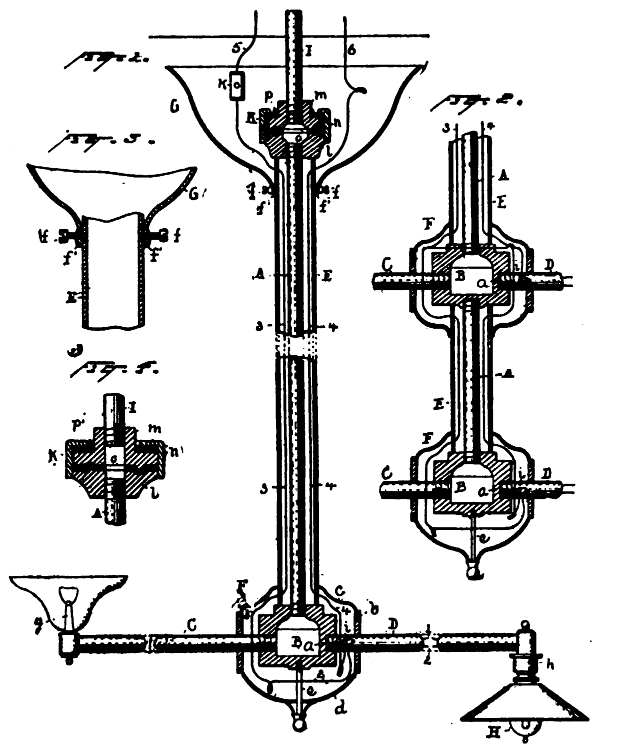
Mr. H. L. Parker, the president of the Emerson Electric Manufacturing Company, writes us that they escaped entirely, their factory not being in the path of the storm. All the homes of the officials were untouched, except that of Vice-President Steinwender. His house was utterly demolished, but his family, we are glad to say, had the great good fortune to escape without any injury.

PATENT NOTES.

THE STIERINGER COMBINATION FIXTURE PATENT.

MR. LUTHER STIERINGER, on May 26, 1896, obtained another reissue patent, No. 11,544, for combined gas and electric light fixture, which, it is claimed, covers the fixtures known as "combination fixtures" employed for illuminating by gas or electricity. The underlying idea of this fixture is to employ separate arms for the gas and for the electric light with a system of conductors directly connected together, so that an integral fixture of unitary design is produced, and in which all of the electrical conductors are concealed, the result being that the fixture practically resembles a gas fixture, the electrical additions in no wise disturbing the harmony of the design.

The claims of this reissue patent are seven in number. The



DRAWINGS OF STIERINGER'S COMBINED GAS AND ELECTRIC LIGHT FIXTURE PATENT.

first four relate to the construction of the fixture to accomplish the purposes mentioned. The fifth and sixth claims include the combination with such a fixture of an insulating joint so as to protect the fixture from the metallic gas pipe outlet. The seventh claim is on a particular form of insulating joint.

It will be recalled that the reissue patent granted to Mr. Stieringer on the simple electric fixture was recently sustained by Judge Coxe. The combination reissue has been taken out on the same lines as the other reissue, by Messrs. Dyer & Driscoll, the attorneys for Stieringer. This reissue patent is of very great importance to the fixture trade, covering, as it does, the combined use of gas and electricity in the same fixture, such fixtures constituting a majority of the entire output.

PROFESSOR A. G. BELL is reported to have been working on an automatic telephone exchange system, which shall enable people to call up each other without the intervention of "central." No details have been given out, and Professor Bell is now away at his summer residence at Cape Breton.

Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

THE ROOT BOILER.

The Abendroth & Root Manufacturing Company, 28 Cliff street, New York City, are distributing some handsomely illustrated leaflets describing the Root boiler, and showing illustrations of a large number of prominent buildings where they are installed. This boiler having been on the market since 1867, is too well known to require special description. Among its claims may be mentioned the fact that it can have any of its details replaced in less than two hours without the services of a practical boilermaker, as all of its parts are made on the interchangeable system. It also admits its circulating water directly to its lower tubes, thus protecting them from the intense heat of the fire. The boiler can be put into any building through an opening 40 inches square, avoiding tearing up sidewalks and streets, and can have its capacity increased at any time at a minimum of cost by placing additional packages of tubes on top or alongside of those already in the boiler. Among the list of users of the Root boilers may be found many of the prominent electric light and electric railway companies.

AN ELECTRIC LIGHT FOR BICYCLES.

It seems that we are at last to have a bicycle lamp that is worthy the name. The Ohio Electric Works, 13 South Water street, Cleveland, have begun the manufacture of an electric lamp that is warranted to burn, to give a light and to last. It is also claimed that it will not go out when a policeman happens to be around.

In its general appearance the new lamp does not differ much from the oil lamps, except that it is narrower and the reflector which holds the lamp projects further from the surface. The body of the lamp resembles a small electric cell more than anything else, and that is really what it is. It is attached to the front of the bicycle in the ordinary position.

The power which supplies the light indicates how common and handy electricity has become. The electrolyte is bought in a solid package and is known as a "charge." The construction of the lamp is so simple that any one can recharge it without difficulty.

The light is furnished by a small incandescent lamp backed by a powerful reflector. The annoyances occasioned by grease, oil and gas are done away with. There is no smell and no smoke, and one charge of the battery is said to be sufficient to maintain the light for several hours.

STORAGE BATTERY PLANT TO BE INSTALLED FOR THE HARTFORD ELECTRIC LIGHT CO.

A water power of about 3,000 horse, situated about eleven miles from Hartford, is to be used to drive Westinghouse multiphase alternators, the power to be transformed at the Falls to 10,000 volts and transmitted on a pole line to the Hartford Electric Light Company's station in Hartford, Conn., where it will operate motors, driving shafting, to which will be belted arc lighting machines, and from which point alternating current will be distributed for incandescent lighting.

From the station mentioned the current will be carried to the storage battery station at a pressure of 2,000 volts, where it will be transformed to 240 volts and put through a rotary transformer for charging the battery which will be operated on three-wire system.

The battery will consist of no fewer than 140 10,000 ampere hour chloride accumulators, the largest such plant in the world.

INTELLIGENT "PIONEER" ADVERTISING.

In looking over the pages of the present edition of The Electrical Engineer, we feel sure that our readers will stop at page V. and give a second look at the pretty and unique notice of the Pioneer enclosed arc lamp. The "Pioneer" folks tell us that their long hour lamp has many imitators, and we trust that their line of advertising will awaken slumbering ideas in the minds of others and thus help us in making every page of our paper attractive and interesting.

ELECTRIC APPLIANCE CO.'S BLANKS.

The Electric Appliance Company have brought out two more very clever and original advertising schemes in the shape of a pad or tablet of blank forms, on which can be recorded thirty minute readings of the number of amperes as shown by the station ammeter. This gives a permanent record of the station load at thirty minute intervals during the entire twenty-four hours.

Their other scheme is a complete set of architects' specifications for electric wiring which can be used as a form for making comtracts for electric wiring. These specifications have been carefully drawn by a well-known consulting electrical engineer and will be found valuable guides in all electric light work. The Electric Appliance Company are prepared to furnish either or both of these free on application.

CRAFTS & ISSERTEL.

This new firm of electrical engineers, contractors, etc., has started in actively and has made a very encouraging début. It is composed of Mr. Henry G. Issertel, E. E., and Mr. S. D. Crafts, and has an abundance of experience and ability. The firm, as one of its chief interests, represents the Walker Manufacturing Company, and has the care of the New York agency. It is very much elated over the recent capture of the order for the Brooklyn Bridge. The firm has its headquarters in the Postal Building.

LARGE PLANS OF THE NEW WALKER CO.

A special dispatch from Albany of May 26 says: A new electrical manufacturing combination called the Walker Company has been formed to fight the General Electric and Westinghouse companies. New York, Philadelphia, Boston and Cleveland capitalists are interested. Among them are ex-Governor Flower, Anthony N. Brady, J. W. Hinckley, Belmont Dallas Sanders, William Rotch, Parker C. Chandler, Frank Billings and Jacob B. Perkins. They have factories in several places, the largest being in Cleveland, where upwards of 2,000 men are employed.

The company has just secured the contract for furnishing the electric plant for the New York and Brooklyn Bridge, also for two railroads in Chicago and for some of the equipment for the elevated railway there, and for roads in Kansas City and Detroit, and for the great store of Jordan & Marsh in Boston. J. W. Hinckley, of Poughkeepsie, who organized the new company, says that no combination will be made with the General Electric and Westinghouse companies. He says the capital of the newly combined companies is only $5,000,000 as against nearly twenty times that amount as represented by the stock and bonds of the General Electric and Westinghouse companies. Mr. Hinckley claims that in consequence the new combination will be able to undersell the trust on all kinds of machinery and still make handsome profits.

WESTERN TELEPHONE CONSTRUCTION CO.

The Western Telephone Construction Company, of Chicago, report a large increase in their orders. Recent contracts are: DuQuoin, Ill., 100 telephones; Ashland, Ky., 150; Bellaire, O., 75; Metropolis, Ill., 60; Oberlin, O., 150; Wauseon, O., 100; Barnesville, O., 200 exchange equipment; Rochester, N. Y., 50 telephone equipments; Ticonderoga, N. Y., 150 exchange outfits. They have also just shipped a 400 telephone exchange equipment to the Mutual Telephone Company, of Petersburg, Va., to replace other apparatus.

I-T-E.

It seems almost impossible to realize with what favor the "I-T-E" automatic magnetic circuit breakers, manufactured by the Cutter Electrical and Manufacturing Company, of Philadelphia, have been received by all those interested in matters electrical. Scarcely a prominent engineer but has approved or indorsed their use, and the underwriters of the cities of New York, Chicago, Boston and Philadelphia have also approved them. As is usually the case in all inventions and improvements, the "thing" or feature is some little modification or development which is apparent at first glance, and which, seemingly, should have been thought of before. The letters "I-T-E" in brief represent the salient features of the automatic magnetic circuit breakers, viz., I-T-E means "Inverse Time Element," and represents the basic principle entering into the construction of the device, namely, that a circuit protected by this circuit breaker is opened in less and less time, as the circuit approaches nearer and nearer a short circuit.

The circuit breakers are made for switchboards, railways, light and power, motors, house service and storage batteries, in direct and alternating circuits.

The catalogue will repay careful reading and will be sent to all interested in this important subject, upon application.

Department News Items will be found in advertising pages.

THE
Electrical Engineer.

Vol. XXI. JUNE 10, 1896. No. 423.

Electric Transportation.

THE EFFICIENCY OF COMPRESSED AIR FOR STREET CAR MOTORS.

BY ROBERT LUNDELL.

THE object of this paper is to correct the erroneous impressions created by the recent newspaper reports upon compressed air motors, and in particular to remove confusion from the minds of the readers of Mr. Herman Haupt's book, "Compressed Air and Electricity." It is admitted that in order to properly answer the statements and conclusions given in this book it would be necessary to write another book of almost the same volume and to deal with mathematics to a considerable extent. This being out of the question at present, it will be sufficient to deal with the main point, that of efficiency.

Mr. Haupt states (see page 10) that 300 cubic feet of free air will run an eight-ton motor car one mile (or 3,600 cubic feet, twelve miles). With an interval of one minute between cars this would mean 3,600 cubic feet per minute. Without criticising the figures, it may be advisable to point out that these remarkably small figures were obtained at Rome, N.Y., under the very best conditions of track, etc. To obtain the same results in speed, etc., under street railway conditions, it is safe to say the horse power must be at least doubled. However, this does not matter at present, as this paper will deal only with the ratio of output to input. We will thus take Mr. Haupt's figures of 3,600 cubic feet of air to be compressed per minute, also the figures in regard to the working pressure, 125 lbs. per square inch, and reservoir pressure, 2,000 lbs. per square inch. We will also assume that no air is lost through leakage, and that the air is reheated to such an extent that it comes out of the motor cylinder at almost the same temperature as it was when it first entered the compressors. This condition, of course, is not obtainable in practice.

Let us now suppose that an air compressor is driving air into a reservoir in which the pressure is 125 lbs., and that an air motor is directly supplied from the same. In order to obtain the highest possible efficiency we may also suppose that the heat generated in the compressor in some ingenious way is utilized in reheating the air as it expands in the motor cylinder. Under these conditions we need only consider the mechanical efficiencies of the compressor and motor.

We may put efficiency of compressor............	80	per cent.
We may put efficiency of motor................	75	" "
Thus, total plant efficiency..................	60	" "

Now, if we could practically carry on a car a reservoir large enough to contain air at slightly more than 125 lbs. at the commencement of the run and slightly less than 125 lbs. at the finish of the run, we might then hope for an efficiency somewhat approximating 60 per cent. But to carry such a reservoir is impracticable, and it has been necessary to compress the air to 2,000 lbs. instead of 125 lbs. per square inch. To compress 3,600 cubic feet per minute to 2,000 lbs. per square inch, a much greater amount of work is required than to compress the same volume to 125 lbs. As the motor cannot utilize any greater pressure than 125 lbs., the additional work done in the station by the air compressors is lost at the pressure-reducing valve. If an air motor could be constructed that could utilize the expansive energy of air from 2,000 lbs. down to 125 lbs. this work would of course not be lost. But as such a motor would be still more impracticable than to carry a reservoir on the car large enough to contain air at only 125 lbs., it now remains to be seen how much work is lost, or, better, how high an efficiency can be expected from compressing air to 2,000 lbs. and utilizing the same at only 125 lbs.

It will be necessary, first, to calculate what horse-power is required to compress 3,600 cubic feet of air per minute into a reservoir where the pressure is 125 lbs., and, second, what horse-power is required to compress 3,600 cubic feet of air into a reservoir where the pressure is 2,000 lbs. We will use the following notations:

L = Work in foot-pounds.
p_1 = 1 atmosphere (2,116 pounds per square foot).
p_2 = Pressure in reservoir in atmospheres.
v_1 = Volume of the air at pressure p_1 (3,600 cubic feet in this case).
v_2 = Volume of the air at pressure p_2.
n = 1.4 (constant).

1. If the air is compressed at constant temperature (that is, if all heat generated by the compression is instantly carried off) the work consumed is calculated according to the formula:

$$(1)\qquad L = v_1\, p_1 \int_{v_2}^{v_1} \frac{dv}{v} = v_1\, p_1 \times \log_e \frac{v_1}{v_2}$$

which gives $L = 3,600 \times 2,116 \times \log_e 8.5$ for a compression to 125 lbs. or 8.5 atmospheres; or the H. P. $= \frac{L}{33,000} = 495$.

If the air is compressed to 2,000 lbs., or 136 atmospheres, we find:

$L = 3,600 \times 2,116 \times \log_e 136$, and the H.-P. $= \frac{L}{33,000} = 1,133$.

We see from this that the work consumed in compression varies as the hyperbolic logarithm of $\frac{v_1}{v_2}$ and that the efficiency under these (the most favorable conditions) is as $\frac{495}{1,133}$ or 44 per cent.

2. If no heat is allowed to escape during the compression, the total work consumed is calculated from formula:

$$(2)\qquad L = \frac{n\, v_1\, p_1}{n-1} \left\{ \left(\frac{p_2}{p_1}\right)^{\frac{n-1}{n}} - 1 \right\}$$

For 125 lbs. or 8.5 atmos., $\therefore L = \frac{1.4 \times 3,600 \times 2,116}{.4} \left\{ 8.5^{\frac{2}{7}} - 1 \right\}$;

and H.-P. $= \frac{L}{33,000} = 678$.

For 2,000 lbs. or 136 atmos., $L = \frac{1.4 \times 3,600 \times 2,116}{.4} \left\{ 136^{\frac{2}{7}} - 1 \right\}$

and H.-P. = 2,480.

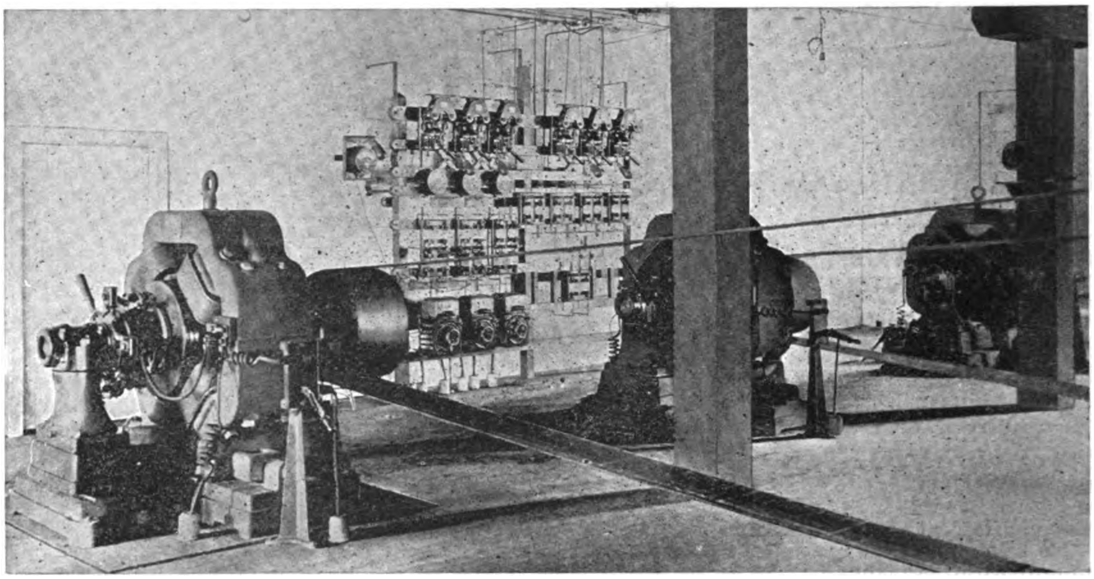
We see from this that the work consumed has increased enormously and in a different ratio from the above case. The efficiency could only be $\frac{678}{2,480}$ or 27 per cent., as against 44 per cent. in the former case. It is fair to assume that if proper means are employed to prevent the temperature from rising too high in the air compressors that an efficiency of about 40 per cent. can be obtained.

Having now determined the efficiency of storing air at a pressure of 2,000 lbs., with a working pressure of 125 lbs., we are ready to estimate the total plant efficiency, leaving out all losses from leakage. In the first part of this paper the mechanical efficiency of an air compressor compressing air to 125 lbs. was supposed to be 80 per cent. But a compressor working under 2,000 lbs. would need more packing and the friction losses would in consequence be considerable. It is liberal to put the mechanical efficiency of the air compressor or compressors at 70 per cent.

Efficiency of storage as before..................	40	per cent.
Efficiency of motor as before...................	75	" "

Or total plant efficiency .70 ÷ .40 × .75 = 21 per cent. under the the most favorable conditions.

It will be understood from the above that reheating of the air at the pressure-reducing value is absolutely necessary. If not reheated the temperature of the air as it enters the engine and finally escapes from same would be so low that its volume would be considerably smaller than when it enters into the compressors at the station. The formation of ice on the working parts would also materially reduce the efficiency.



Power Installation, Youghiogheny River Coal Company.

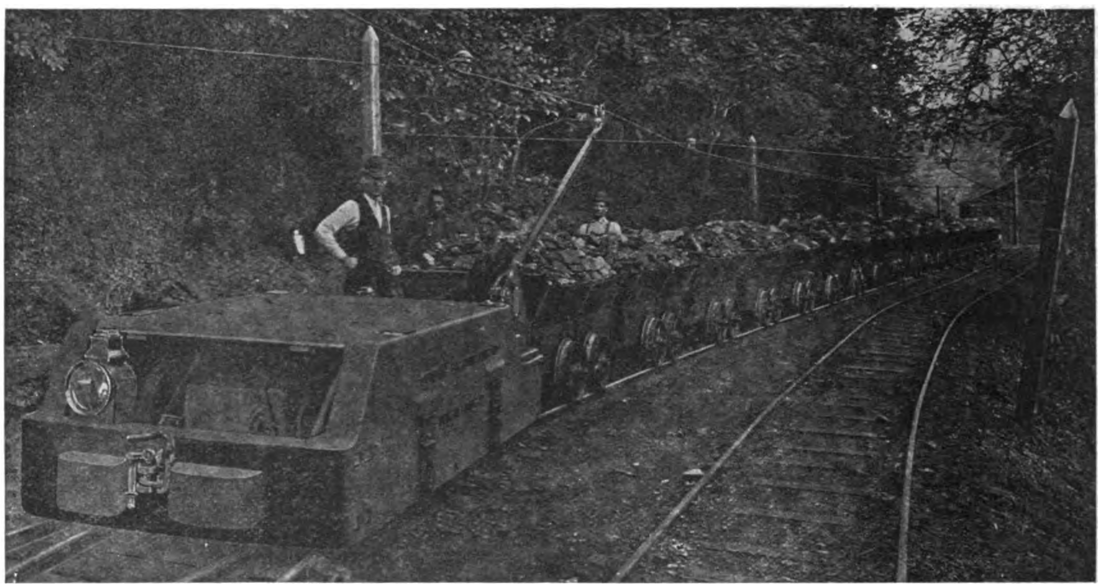
ELECTRICITY IN THE YOUGHIOGHENY RIVER COAL CO.'S MINES.

AN interesting electrically operated coal property in the Pennsylvania field is that of the Youghiogheny River Coal Company, at Scott Haven, Pa. The mines in which the different machines driven by electric power are installed, are scattered over a large extent of territory.

The power house is located on the east side of the Youghiogheny River contiguous to the line of the B. & O. Railroad. It was formerly a bonded warehouse and contains, not only the machinery, but also the stores and offices.

The engine room is 74 feet long by 54 feet wide, and is separated by a brick wall from the power house. The engine installation consists of three automatic engines, each 15 x 16 inches, with seventy-two-inch fly wheels, running at 240 revolutions. Each engine is belted to a four-pole 650 revolution, 100 kilowatt General Electric generator, wound for 500 volts, and overcompounded for 10 per cent. loss in the line. The engines and dynamos are erected on brick foundations, and current from the generators is carried under the floor to the switchboard by heavily insulated cables hung on porcelain insulators.

The switchboard is of the skeleton type, divided into two parts, one for the generators and one for the feeders, on a plan similar to that used in electric railway stations. The generator board carries three automatic circuit breakers, three circular dial Weston ammeters, three main double-pole, double-throw switches and three field rheostats. The voltmeter is carried on a bracket on the side. Two sets of circuits are run, one of which is grounded, for haulage work, and the other insulated, for the fans, coal cutters, etc. Any machine may be run on either the insulated or the grounded circuit. The feeder switchboard carries an automatic circuit breaker for each of the haulage circuits, a double-pole switch for each pump circuit, fan circuit and the coal cutter circuit, and a double-pole switch for throwing the metallic and grounded bus bars into multiple. Lightning arresters protecting the generators are placed behind the switchboard. From the power house the circuits for No. 1 mine are run on poles to the mine mouth. This mine is about 900 feet from the power house and the circuit is used to drive fans, pumps, locomotives



Electric Haulage of Coal, Youghiogheny River Coal Company.

and coal cutters. The fan is a Capell exhaust fan 8 x 3½ feet in diameter, running at 280 revolutions per minute, driven by a belted 25 horse-power multipolar motor, running at 650 revolutions.

All the coal cutting is being done in No. 1 mine by five Jeffrey chain coal undercutters, operated a mile and three-quarters from the power house. The circuit for the coal cutters is insulated, the other circuits all having earth return. This mine is also provided with a Knowles triplex pump, 6½ x 8 in., driven by a 7½ horse-power multipolar motor. The pump, motor and rheostat are mounted on an iron truck and may be run over the track from place to place in the mine.

The electric locomotive operated in this mine has a length of haul a little over a mile and a quarter. The grades vary from 1 per cent. against loads, to 25 per cent. in their favor. The track is laid on thirty-pound rails with a gauge of 43½ inches. The overhead construction is of the regular mining type. The pump and haulage circuits are all grounded for the return.

The fact that the various mines are separated from each other by water introduces a novel feature into the installation and illustrates the flexibility of electric power transmission. For each of the other mines in the Youghiogheny Company's system, current has to be carried under the Youghiogheny River by heavily insulated and armored cables, to a small cable house, forming the center of distribution for the lines running to the mines on the west side of the river.

In No. 4 and in the southwest mines, electricity is applied to pumping purposes only. The pumps are triplex pumps, similar to those in No. 1 mine, and are driven by two multipolar slow-speed motors of 10 horse-power and 7½ horse-power, respectively. These pumps are about 8,000 feet away from the power house.

In the Pacific mine the haulage is effected by a locomotive having a drawbar pull of 2,500 lbs., with a length of haul of about 5,000 feet underground and 800 feet in the open. This mine also contains a pump, similar in size to that in No. 1 mine, driven by a 7½ horse-power motor, located about 16,000 feet from the power house. A 30 horse-power motor fan is erected about 1,000 feet beyond the pump. The installation of the electrical apparatus in No. 5 mine is not yet completed.

In the new steel tipple of No. 1 mine a 7½ horse-power motor drives a revolving screen and runs an emery wheel for sharpening bits, etc. The installation of electricity in this mine has proved of considerable benefit from every point of view. A fair idea can be obtained of the economical value of electric haulage from the statement that the two locomotives have displaced eighteen mules and their drivers, and the four pumps, which take only a small share of the attention of three separate men, are doing the work with which ten men, four mules, two steam boilers, and two steam pumps formerly found it difficult to cope.

THIRD RAIL TESTS ON THE NANTASKET BEACH ROAD.

ELECTRIC traction by means of a third rail was thoroughly tested by officials of the New Haven road at the Nantasket power station recently. It is pretty definitely settled that the overhead system now in use on the Nantasket branch will be abandoned in favor of the third rail, and contracts have already been made for the equipment of part of the line.

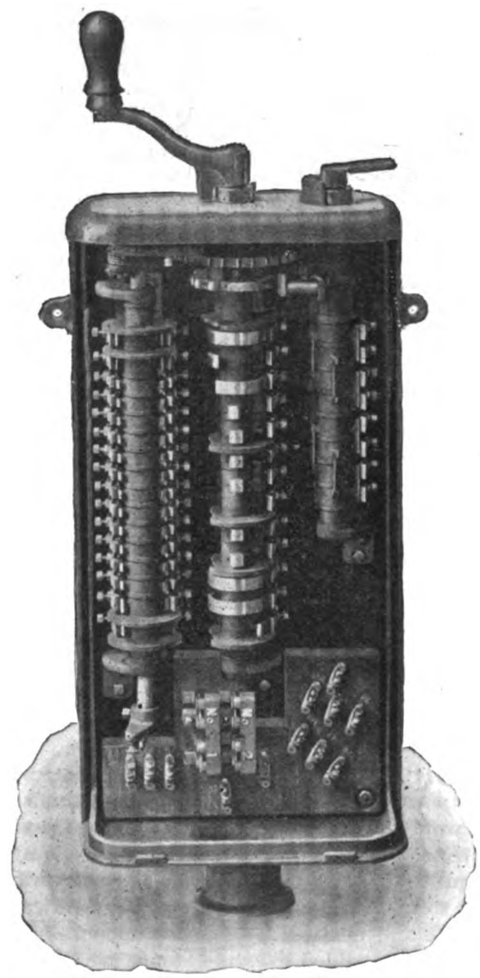
The trial was thoroughly satisfactory, and those who were present expressed themselves as being confident that the system will be successful. It was effectually demonstrated that great speed and efficiency could be obtained, fully as great, in fact, if not greater than, with the overhead system. The rail is alive for its whole length, and will be equipped with some protection similar to that in use on the Intramural Railway at Chicago. Each rail is mounted on three blocks of wood, which keep it from touching the ground. It is broad and flat, and has a flange at each edge which reaches down over the blocks of wood, giving a sort of inverted V shape to the whole, as seen end on. The application from the car is not made by a wheel, as in the overhead system, but by a shoe, which slides along the top of the rail. The blocks on which the rail rests are about six inches square and four and one-half inches high, the height of the whole structure being six inches from the trestle. The rails are coupled with copper bonds, which take the place of fish-plates on the ordinary rail, and are bolted to the flanges where they project over the blocks of wood. The whole structure projects about one and one-half inches above the rails.

THE WALKER "TYPE E" STREET CAR CONTROLLER.

THERE is probably no other class of apparatus that has to operate with as little attention and under as much abuse as that employed in the operation of street cars. It is very necessary that this fact be borne prominently in mind in designing machinery for such service.

The controller is one of the most important elements of a railway outfit. Controllers that two years ago were operated satisfactorily under the general run of service, would now prove inadequate on account of the increased requirements. With these facts in mind the Walker Company has, during several months past, built and experimented with a number of different forms of controllers with a view to determining the most practical and simplest form to place upon the market.

As no means is known of breaking a circuit of high self-induction without forming an arc, efforts have been directed to devising methods of breaking which will be as little destructive as possible to the terminals and other apparatus. On account of the induction effect a short break is more injurious to the insulation than a slow break is, but with the latter a long arc will be produced. After a large number of practical tests it was found that the principle of drawing a long arc with a relatively slow break gave the most satisfactory results. Consequently this principle has been adopted in the design of the new controller recently brought out by the Walker Company. In this controller the circuit is broken by a special switch placed in the controller, in which the action is relatively slow and the circuit is broken at twenty-eight points, thus very easily rendering the most severe arc that can be formed in practice entirely harmless both as to spreading to other contacts and as to its effect on burning the breaking contacts themselves.



WALKER STREET CAR CONTROLLER.

Another novel feature has been adopted, which consists in entirely separating the operation of breaking the circuit from the controlling cylinder itself. The controller consists of two switches, each having its own separate function to perform. The controlling cylinder proper is used simply to make the

different combinations required to obtain the proper regulation of the speed of the car. The second switch is also of a cylindrical form, but is used for no other purpose than the complete breaking of the circuit whenever such is required. By reference to the accompanying engraving, it will be seen that the breaking switch, which is shown at the left, has its circuit so arranged that the main current passes first through this switch before going to the controlling cylinder. In the four lines of contacts shown, the first and third constitute the cylindrical portion of the switch and are in metallic connection each with the one horizontally opposite to it. The second and fourth rows represent the fingers bearing upon the cylinder contacts. It will be seen by following out these connections that when the switch is closed the upper contacts shown in outline are short circuited, the current simply passing from top to bottom and then direct to the controlling cylinder. As this switch is opened the fingers leave the lower contacts, shown solid, first throwing the main current through the upper breaking contacts in the series, so that when the fingers leave the cylinder contacts the arc is broken up into as many parts as there are breaking fingers.

The mechanism of the breaking switch is so arranged that with a movement of the controlling handle one-quarter of an inch backward, the circuit is completely opened leaving the controlling cylinder itself entirely dead. The circuit cannot be again closed until the controlling handle has been brought back to the off position. After the circuit has been once opened by this slight backward movement of the handle, the controlling cylinder can be moved backward and forward into any position without producing any effect, and it is absolutely necessary to go back to the off position before the switch can be again closed. This feature of the controller makes it impossible to drop back from one notch to another in such a way as to put in or take out resistance in the circuit. Another point of advantage is the quickness with which the current is thus cut off.

A very simple and effective interlocking device has been adopted in this controller in which the pawl that indicates the various running positions of the controlling cylinder acts at the same time as a lock between the controlling cylinder and the reversing switch. The internal wiring of the controller is very simple, and, as will be seen, is entirely open, so that it can be easily reached. With this efficient method of breaking the circuit it has been found that separators between the various contacts are unnecessary. In fact the arcing in this controller under the severest conditions of practice is so slight that it is scarcely noticeable.

One of the important features of the controller is the ease with which all the parts can be reached when necessary. The breaking cylinder is so designed that when from continued use the contacts have become worn, the cylinder can be turned end for end and the opposite edges of contact brought into service, thus practically completely renewing the cylinder itself.

THE HORSELESS CARRIAGE RACE.

Of the twenty-eight horseless carriages which it was announced would participate in a parade on Decoration Day, starting from City Hall Park, New York City, only six put in an appearance up to 12 o'clock, when the start was made. On their way through the city the six carriages attracted considerable notice and elicited favorable comments on the part of spectators. They glided over the stones with great ease. The engineers of the novel vehicles experienced no difficulty in making their way through the crowded thoroughfares.

A race was also a part of the programme. This began at Kingsbridge and ended at the Ardsley Country Club. The route was by way of Yonkers, Hastings and Dobbs Ferry. The judges invited to decide upon the winner were General Nelson A. Miles, Chauncey M. Depew, Frank Thompson, vice-president of the Pennsylvania Railroad, General W. P. Craighill and John Jacob Astor. One or two of the carriages returned to the City Hall by the same route, not all of them being able to hold out. There were no electric competitors.

THE TRUMP MANUFACTURING CO., Springfield, O., are building a waterwheel for the Oswego Street Railway Company, of 642 horse-power, 16 feet head, the largest single wheel that can be built and shipped.

THE ELECTRIC CARRIAGE AND WAGON CO., of New York City, has been formed to make and sell storage battery vehicles. Its capital stock is $300,000. The directors are H. G. Morris, W. W. Gibbs, P. G. Salom, I. L. Rice, P. L. Anderson, R. B. Hartshorne, and W. Halls, Jr.

POWER TRANSMISSION.

MOTOR CONTROL.

BY JAMES BURKE.

THE ELECTRICAL ENGINEER of May 6 contains a criticism by Prof. Anthony of a method of motor control devised by the writer, and explained in The Electrical Engineer of April 15.

Prof. Anthony bases his arguments on the application of this method to conditions in which a constant power is required at variable speed and also to conditions in which a constant torque is required at variable speed, and consequently a variable power. In considering the latter conditions, Prof. Anthony misapplies this method of regulation, for it is clearly stated in the description of the method that the conditions are the delivery of "10 horse-power at any speed between the limits of 100 and 500 revolutions," and Prof. Anthony considers an entirely different problem in which the conditions are the delivery of a variable power, varying from 10 horse-power at 100 revolutions to 50 horse-power at 500 revolutions. By this misapplication it is shown how enormous the machines would become, which fact would in itself indicate that the method was being applied to a problem which it was not intended to solve.

Prof. Anthony compares this method, applied to the problem of constant torque, with a system in which a rotary transformer is used, and finds that the latter requires much less machinery, but if the comparison is made on the basis of the application to the problem stated, namely, constant power, it will be seen that his conclusion becomes reversed, because this method requires two motors of 5 horse-power each, at 100 revolutions, and the rotary transformer method requires one motor of 10 horse-power, at 100 revolutions, and also a rotary transformer consisting of a motor and a generator, each of which has an output greater than 10 horse-power.

The writer does not intend herein to criticise the systems in which rotary transformers are used, for there are many conditions which the rotary transformer systems fulfill better than any other, but the problem under discussion is not one of them.

Prof. Anthony's argument against the application of this method to the problem stated, namely, the delivery of 10 horse-power at any speed between the limits of 100 and 500 revolutions, in which the writer uses two motors, each of 5 horse-power, at 100 revolutions, seems to be stated in the following quotation from his criticism: "By making one machine capable of delivering 10 horse-power at 100 revolutions—a machine that would be less costly than two machines of 5 horse-power each—the regulation of speed could be obtained by varying the strength of its own field, with the same facility as by the method described by Mr. Burke." In other words, Prof. Anthony proposes to use a 10 horse-power, 100 revolution motor, and to increase the speed to 500 revolutions by reducing the strength of field to one-fifth its normal strength and maintain a delivery of 10 horse-power.

The writer believes this to be impracticable, because, although this range of field variation can be accomplished when a motor is doing no work, still, it is not possible with constant voltage on the armature and constant delivery of the normal power, to operate a motor successfully with the field reduced to one-fifth its normal value. This conclusion is the result of tests on several machines wherein it was desired to determine the limits of speed control by field variation. This must not be confused with conditions in which a reduction of voltage on the armature accompanies the reduction of field strength and where a reduction in delivery of power in the machine takes place.

In conclusion, the writer wishes to say that the many different problems which arise in the operation of electric motors from supply circuits are so varied that several systems of operation and control have been devised, each applying to some special problem or class of work. Each of them has its place and must not be misapplied. It will be of interest to note that the particular problem of 10 horse-power, at all speeds has been met with in several instances by the writer; also that the particular problem of 10 horse-power, at all speed from 100 to 500 revolutions is one that has been met with in actual practice. The method pointed out by Prof. Anthony, namely, control by varying the strength of the motor field, although useful in many instances where a small range is required, would be inoperative if applied to the conditions of the problem stated, and is therefore not considered practical in this instance.

New York, May 18, 1896.

MISCELLANEOUS.

A METHOD OF INCREASING THE STRIKING DISTANCE OF A GIVEN E. M. F.

WHILE experimenting with high tension apparatus, to determine the effect of different terminals and different arrangements of circuits on striking distances, I observed the following interesting phenomenon:

A spark gap was arranged as shown in Fig. 1. The spark gap terminals, C D, consisted of 1-inch cylindrical brass rods turned to hemispherical shape on the ends. The glass plate was placed in contact with the two terminals. A sheet of tinfoil about 6 inches by 10 inches was placed on the opposite side of the glass plate from the terminals, and bridging the space

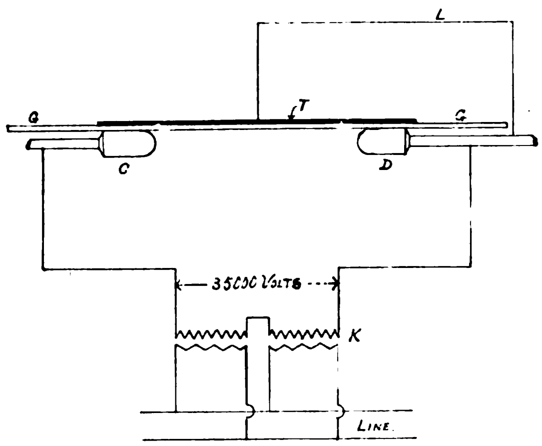


FIG. 1.—C, D, SPARK GAP TERMINALS; G, G, GLASS PLATE; T, METAL FOIL; L, CONNECTION BETWEEN D AND T; K, BANK OF CONVERTERS GIVING VARYING E. M. F.'S UP TO 35,000 VOLTS.

between them. This tinfoil was electrically connected to the terminal D. It was found that with arrangement the striking distance of the e. m. f. used was many times increased above that which could be obtained if the glass plate and tinfoil were removed, or if the connection between the terminal D and the foil was broken.

In the first experiments made, a bank of converters giving a maximum e. m. f. of 35,000 volts at 16,000 alternations per minute was used. The striking distance in air with 1-inch hemispherical terminals was about .7 inch. The striking distance with the glass plate and the tinfoil connected as shown was

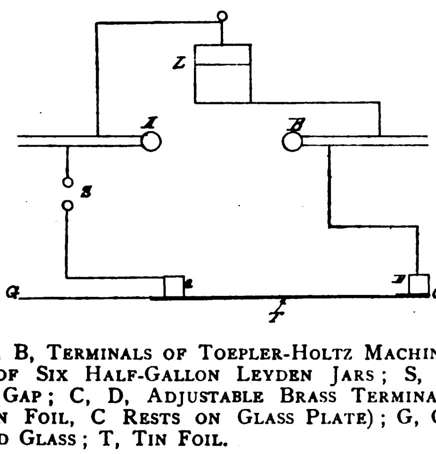


FIG. 2.—A, B, TERMINALS OF TOEPLER-HOLTZ MACHINE; L, BATTERY OF SIX HALF-GALLON LEYDEN JARS; S, ADJUSTABLE SPARK GAP; C, D, ADJUSTABLE BRASS TERMINALS (D RESTS ON TIN FOIL, C RESTS ON GLASS PLATE); G, G, PLATE OF GROUND GLASS; T, TIN FOIL.

between 5 and 6 inches. A condenser connected in series between the terminal and the tinfoil did not materially change the result. Duplicating the tinfoil and glass plate on the opposite side of the terminals from the first and connecting the second tinfoil to the terminal D gave a slightly increased result. Connecting the two plates of foil to the same terminal gave the same result as connecting them to opposite terminals. Additional experiments, with the same arrangement of terminals as detailed above, showed that the striking distance of a given e. m. f. could easily be increased to more than ten times the striking distance of the same e. m. f. directly through air.

It was noted when the arc was first formed with the single plate it followed the surface of the glass very closely and that it usually took a roundabout way between the terminals instead of across in a straight line; also that the arc was rarely formed in the same place twice in succession.

An interesting variation of this experiment was made by placing a wire in a small glass tube with pieces of tinfoil on the outside of the tube, the wire corresponding to the tinfoil plate and the tinfoil to the spark gap terminals, the wire being connected to one of the pieces of tinfoil. The striking distance obtained in this way was about the same as that given by the arrangement first described. When the spark gap terminals were placed inside the tube and the wire on the outside, the tube was instantly shattered by the heat from the arc.

Later some experiments were made, substituting a static

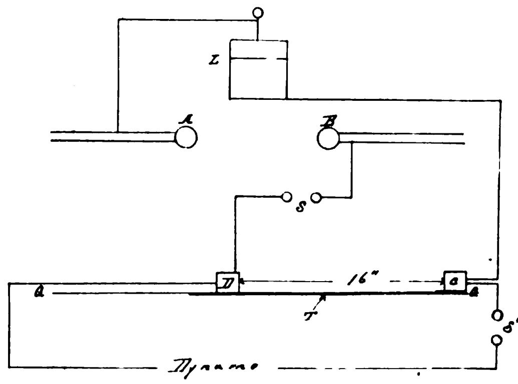


FIG. 3.—A, B, TERMINALS OF TOEPLER-HOLTZ MACHINE; L, BATTERY OF SIX HALF-GALLON LEYDEN JARS; S, ADJUSTABLE SPARK GAP; G, G, PLATE OF GROUND GLASS; T, TIN FOIL; D, C, NON-ARCING LIGHTNING ARRESTER BLOCKS; S, THREE-QUARTER-INCH SPARK GAP.

machine and a bank of Leyden jars in place of the bank of converters. The arrangement of the terminals and the spark gap was the same as before. With this arrangement the striking distance which was obtained from the discharge of the bank of Leyden jars was increased eight or ten times above that which could be obtained when striking directly through air, or along the surface of the glass plate with the connection between the tinfoil and the terminal C broken.

To account for this phenomenon at the time the experiments were made I advanced the following hypothesis: Suppose that the terminal D is positive; C will be negative; the sheet of tinfoil connected to D will be positive and a negative charge will be induced on the surface of the glass plate between the terminals C and D. This charge apparently acts as an extension of the terminal C toward the terminal D, and thereby assists the e. m. f. to strike across.

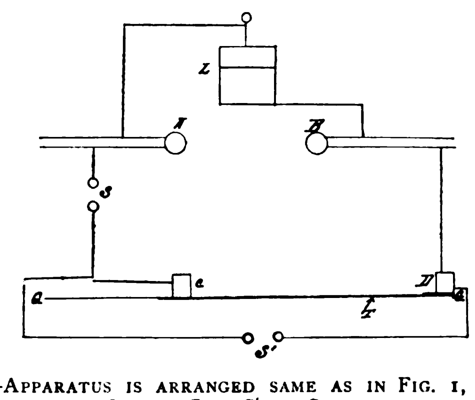


FIG. 4.—APPARATUS IS ARRANGED SAME AS IN FIG. 1, WITH THE ADDITION OF SPARK GAP S' IN SHUNT TO THE TERMINALS C, D.

When this phenomenon was first observed I saw that it might be useful in the construction of lightning arresters, as the apparent resistance of a given length of spark gap might

be greatly decreased, or for a given resistance the length of the gap might be very materially increased.

C. E. SKINNER.

Following Mr. Skinner's suggestion relative to the construction of a lightning arrester with a reduced striking e. m. f., as already described by him, I instituted a series of tests, with the object of constructing, if possible, some simple form of lightning arrester for high potential circuits. The following are the experiments which were made:

In each case the apparatus consisted of a Toepler-Holtz induction machine and a battery of six half-gallon Leyden jars, a plate of ground glass partially covered on the lower and smooth side with tinfoil, which on one end lapped over to the upper side; also various details which will be mentioned in the individual experiments. The connections are all clearly shown in the respective diagrams.

First Experiment.—Variation in length of spark due to different surfaces in its path. See Fig. 2.

The results obtained are given in the following table:

Character of Ground Glass Surface.	Length of Spark.	Distance between Machine Terminals A and B.	Remarks.
Plain	7¾ inches.		
Lead pencil mark	16¾ "		
Plain	12 7/16 "	1⅛ inches.	This measurement was taken after first pencil mark had been removed. Probably, however, particles of plumbago still remained on the glass surface.
Lead pencil mark	17 5/16 "	1 7/16 "	
Lead pencil mark	19 "	1 9/16 "	Marks made heavier.
Plumbago	23¾ "	1⅛ "	
Plumbago	24⅝ "	1⅛ "	

The last figure in the second column, 24⅝ inches, is the maximum spark which was obtainable under the conditions. The length of the plate was such that any further separation of the electrodes C D caused the spark to pass back from C around to T. In the above experiment spark gap S was maintained constant at ⅝ inch. In the third column there is given the distance in inches between the machine terminals A B, which, under the conditions of the test, balanced the distance between C and D; that, is the distance between C D having been fixed, the terminals A B were so adjusted that sparks would indiscriminately pass between A B or C D.

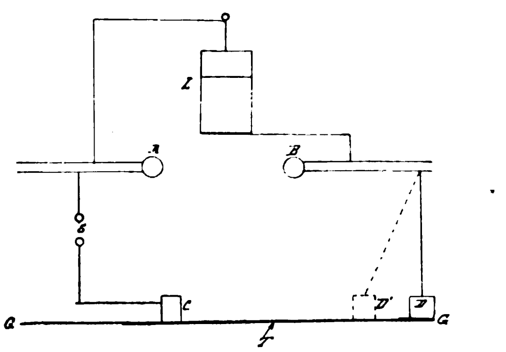


FIG. 5.—APPARATUS IS ARRANGED SAME AS IN FIG. 1, THE TERMINAL D BEING ARRANGED TO SHIFT FROM ITS POSITION ON THE TIN FOIL TO THE POSITION D′ ON THE SURFACE OF THE GLASS PLATE G, G.

Second Experiment.—The terminals of a high potential alternating current circuit were connected to the terminals C D, and the static apparatus removed, the object being to learn what effect the plumbago surface of the glass would have in connection with the high potential alternating current circuit; also to determine what conditions were necessary to prevent brush discharge between the terminals C D.

It was found that with 3,000 volts a heavy brush discharge reached almost the entire distance between the terminals C D. The streak of plumbago over the glass did not seem in any way to affect the path of the discharge, the discharges occurring indiscriminately over the plumbago and clean surfaces as well.

A ¼-inch gap was now placed in the high potential circuit and the voltage lowered by steps to 15,000, at which point there seemed to be a leakage with considerable hissing across the spark gap, but without brush discharge on the plate. At 12,000 volts the leakage ceased altogether. The distance between C and D in the above experiment was maintained at 24⅝ inches.

Third Experiment.—Steps were now taken to determine whether or not it were possible to prevent the dynamo current of a high potential circuit from following the static discharge over the glass plate. In this experiment the terminals C D, Fig. 3, consisted of the lower block of a non-arcing railway lightning arrester cut in two, one half being placed at C, the other half at D; the object of these blocks being, as in the case of the non-arcing railway lightning arrester, to suppress tne formation of the metallic vapors at the electrodes, which are necessary for the formation and maintenance of a dynamo arc.

The results of this experiment are given in the following table:

With and Without the Lightning Arrester Blocks.	Voltage.	Distance between Blocks.	Remarks.
With blocks	12,000	1 inch	Dynamo current followed the discharge.
" "	12,000	3 inches.	No current followed the discharge.
Without blocks.	12,000	4¼ "	Dynamo current followed the discharge.
" "	12,000	6 "	No dynamo current followed the discharge.
" "	15,000	6 "	Dynamo current followed discharge.

From the above table it will be noted that there is a decided difference in the tendency for the dynamo current to follow the discharge when the protecting blocks are used and when they are not used.

Fourth Experiment.—It was next decided to determine the relation existing between the distance C D and a spark gap S′, with rounded electrodes connected in shunt to C D. See Fig. 4. The results are given in the following table:

Length of Spark between C and D.	Equivalent Length of Spark in Air at S′.
2 inches.	20/32 inch.
2½ "	20/32 "
3 "	19/32 "
3½ "	20/32 "
4 "	21/32 "
4½ "	24/32 "
5 "	25/32 "
5½ "	25/32 "
6 "	25/32 "
6½ "	26/32 "
7 "	27/32 "
7½ "	28/32 "

After the last measurement given in the above table no further relation appeared to exist between the two gaps, for having fixed C D at 10 inches the spark would continue to pass between the points C D in preference to the air gap, although C D was lengthened to 17 inches, the air gap remained constant at 29-32 inch. On the other hand, leaving C D constant at 12 inches and having once started the spark at the air gap, even though the latter was lengthened to a far greater extent than in any previous case, the spark continued to cross the air gap .

Fifth Experiment.—To determine the relation between the spark lengths, first, when D is connected to tinfoil, and, second, when there is no such connection. See Fig. 5. The results are given in the following table:

Character of Surface.	Spark Length.	Remarks.
Plain	8½ inches.	D connected.
"	2¼	D not connected.
Plumbago	29¾	D connected.
"	17¼	D not connected.

Twenty-nine and three quarter inches is the longest spark which has been obtained with the static apparatus at hand, namely, six half-gallon Leyden jars and a 6-inch spark Toepler-Holtz machine. The spark was thick and was accompanied by a loud report.

Theory.—While observing the various experiments which have been described, it was noted that light particles dropped on the surface of the glass were repelled. I subsequently analyzed as follows the phenomenon which Mr. Skinner has discovered, taking as a basis for my reasoning the doctrine of the conservation of energy:

A spark in passing from one electrode to another must perform a certain amount of work. In passing through air the work done depends upon the difficulty with which the air is displaced and torn asunder. By experiment it is found that the spark will pass more easily over a surface than through the air. For a given spark length there is therefore less work

performed in forcing the spark over a surface than through the air; in other words, it is easier to separate air from a surface than to separate air from air. The molecules of air are in more intimate contact with each other than are the molecules of air with the molecules of a surface. The addition of plumbago to a surface obviously plays the part of a conductor, and although of not sufficient carrying capacity to conduct the discharge in the sense that a copper wire conducts, still there is conductivity present, and I regard this conducting film, as it were, in the nature of an electric crack through the dielectric. The presence of the metallic coating on the under side of the plate causes repulsion on the upper side. The air repelled from the plate is therefore less dense in the immediate vicinity of the plate than when the under side is not coated with the metal foil. In consequence of this rarefaction of the air over the upper surface of the glass, a spark will perform less work in passing over this surface than when the air has not been thus rarefied. Starting therefore with the work performed by a given spark length in air, the work performed by the same spark length is successively diminished by, first, causing the spark to pass over a surface; second, by smearing the surface with plumbago; and third, by causing a rarefaction of the air in close proximity to the surface.

A high potential lightning arrester has been constructed on the principles described, and although not yet tested in actual practice, the indications are that it will prove effective on circuits up to 30,000 volts. A. J. WURTS.

ASBESTOS.

BY GEORGE HELI GUY.

I.

THERE is probably no product of inorganic nature about which there is so much popular mystery and misconception as asbestos. It is vaguely understood that the principal claim of this remarkable product to attention is that it cannot be consumed by fire, and not infrequently the effect of the mention of asbestos is to carry the hearer back to the far-off Egyptian days when the people of the Pharaohs wrapped their dead in cere-cloths woven from the fibre, in order to preserve them, the body having been first embalmed with aloes and subtle essences, so that no noxious exhalations should disturb a community in which fear of pestilence had become a hereditary instinct. Romantic stories have also come down to us of ancient demonstrations of magic in which asbestos has played the leading part, but the real and vital interest in asbestos centers in the present. It is of more importance to the human race to-day than it has been in the whole range of history. Asbestos twenty-five years ago was practically not known outside the laboratory of the chemist or mineralogist. It now finds its way in one form or another into every workshop where steam is employed. To the question: "What is asbestos?" it is not altogether easy to find an answer. Geologists classify it among the hornblendes. In itself, asbestos is a physical paradox, a mineralogical vegetable, both fibrous and crystalline, elastic yet brittle, a floating stone, but as capable of being carded, spun, and woven as flax, cotton or silk. It is apparently a connecting link between the vegetable and the mineral kingdoms, possessing some of the characteristics of both. In appearance it is light, buoyant, and feathery as thistledown; yet, in its crude state, it is dense and heavy as the solid rock in which it is found. Apparently as perishable as grass, it is yet older than any order of animal or vegetable life on earth. The dissolving influences of time seem to have no effect upon it. The action of unnumbered centuries, by which the hardest rocks known to geologists are worn away, has left no perceptible imprint on the asbestos found embedded in them. While much of its bulk is of the roughest and most gritty materials known, it is really as smooth to the touch as soap or oil. Seemingly as combustible as tow, the fiercest heat cannot consume it, and no known combination of acids will destructively affect the appearance and strength of its fibre, even after days of exposure to its action. It is, in fact, practically indestructible. Its incombustible nature renders it a complete protection from flames, but beyond this most valuable quality, its industrial value is greatly augmented by its non-conduction of heat and electricity, as well as by its important property of practical insolubility in acids.

II.

Asbestos has been found in all quarters of the globe. It comes from Italy, China, Japan, Australia, Spain, Portugal, Hungary, Germany, Russia, the Cape, Central Africa, Canada, Newfoundland, Texas, and other parts of this country, and from Southern and Central America. Scarcely a week passes without the opinion of experts being asked on some new discovery of this mineral substance. Most of the samples are, if not of poor quality, very much inferior to the best. The asbestos of different countries is as varied as the characteristic foliage. The smooth and white, rock-like form of the mineral from the Pyrenees is an absolute contrast to the harsh and brittle tremolite of Servia, unpleasant to handle, with its fine needles like the particles of slag wool, which insidiously penetrate the skin. The Corsican variety is long, soft and silky, its silvery white or pale gold tufts resembling skeins newly wound from a cocoon, while the singular Scandinavian forms are rough and rugged as the country from which they come. It may be said here that while the appearance of asbestos is often very deceptive as a gauge of its commercial value, the points most sought for in the mineral are the length and fineness of fibre, combined with infusibility, toughness and flexibility.

The asbestos generally found in the United States, especially in Virginia, the Carolinas and Texas, also in Staten Island, New Jersey and Pennsylvania, is of the woody form, in appearance like fossilized wood. The veins range in length from a few inches to several feet. The fibre can be split off like soft wood, the appearance being woolly, and when separated it has no strength or cohesion. It cannot be spun nor even pulped. At one time it was thought it might be profitably used as a filler in paper making, but virtually it is of no commercial value. This and kindred classes of asbestos have often been instrumental in the creation of visions of wealth that were never to be realized. A sensation was recently caused by the announcement that a whole mountain of asbestos had been discovered in Oregon. The fibre was reputed to vary from ½ an inch to 2 inches in length, and to be of excellent quality. The discovery was made through the herding of sheep on a mountain side. The value of the find, however, was discounted in the eyes of experts by the supplementary

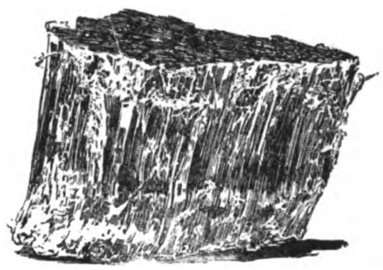


FIG. I.—CANADIAN ASBESTOS.

statement that where the flock had trampled the rock, the asbestos threads showed up like bunches of wool.

III.

Notwithstanding this wide distribution of asbestos, the only varieties which at present appear to demand serious consideration, from a commercial point of view, are the Russian, the South African, the Italian, and the Canadian. The principal claim possessed by the Russian fibre to a place in this quartet is based on the enormous extent of the deposits which have been discovered in East Russia, beyond the Ural Mountains, and Russian Siberia. So far, their specimens have been of comparatively poor quality. The yield is used almost entirely in Europe, where it is mixed with the Canadian for spinning, paper making, and other purposes where an inferior grade can be utilized.

Africa has been stigmatized as "a country of samples," but the fact that she has furnished the world with six tons of diamonds, a thousand tons of ostrich feathers, and with gold and other produce in equally fabulous quantity, cannot fail to have weight in securing a careful consideration for her newer products. Crocidolite, or blue asbestos, occurs in apparently inexhaustible quantities in the Great Orange River Mountains, South Africa, about 700 miles from the Cape of Good Hope. It is found in two forms, fibrous and earthy. The former is of a peculiar lavender blue or leek-green color, possessing long, delicate-looking fibres, which are somewhat elastic and easily divisible. The color is caused by the large proportion of oxide of iron it contains. It is dry and compact, and when fiberized has the look and feel of wool. The fibre varies from half an inch to three inches. Its exceptional tensile strength, which is attributable to its excess of iron, is neutralized (for present purposes), by a corresponding lack of fireproofness. It has but little lime or magnesia, and consequently, when exposed to fire, it weakens and crumbles. For electrical purposes, it is, of course, out of the question. Its chances of coming into the market to any extent, as asbestos, are not promising; but it may for many purposes come to supersede certain other fibres, such as wool, which are much more expensive.

Before the development of the Canadian fields, the Italian asbestos was supreme in the market. For nearly twenty years Italy has been looked to for the best grades of the fibre. From a point on the northern mountain slope of the Susa Valley is taken the floss asbestos fibre, the appearance of which in gas stoves is so familiar. In the same locality is found a fine white powder of asbestos, which serves for paint and other purposes. The mining is carried on at a height of from 6,000 to 10,000 feet above sea level. The temperature is, of course, low, but the inhabitants are hardy and robust, and make willing miners. The works are reached by mule paths, for some distance, but many miles have to be traversed on foot, and the journey to the plain takes from four to five hours. The mode in which the material is brought down the mountain side is by loading it on a sort of toboggan, which slides as easily over the rocks as over snow; and so expert are the inhabitants at this work that two men can bring down eight hundredweight of asbestos in three hours. In searching for asbestos on the Italian hills, the prospector looks in the perpendicular face of the rock for cracks. These may be filled with a white powdery substance, which, after abrasion, assumes a leathery appearance, and is followed, further within the rock, by the true asbestos. The wily art of "salting" is not unknown in these regions. It consists in driving fine asbestos fibre into crevices of the rock, which have been previously primed with the interstratum of leathery consistency, and possibly a foundation of asbestos. In this way many concessions for mining on absolutely barren rock have been sold at high prices. While the Italian asbestos possesses a larger percentage of magnesia, it is poorer in alumina, and holds more water than the Canadian. The Italian, obtained in long fibres—sometimes reaching three feet—cannot be worked with the same ease and evenness as the Canadian. The product is not so uniform, and its greater density and weight render it more expensive and less desirable for general use. A further radical disadvantage is that whilst Canadian asbestos fibre can easily be spun into thread for manufacturing into rope or cloth, Italian cannot be so spun commercially. For manufacturing purposes it is separated into three divisions: 1. The long fibred quality, which is set aside for spinning and weaving. 2. The shorter fibred material, which is made into millboard and paper. 3. The powdery material, part of which is converted into cement, paint, etc., while a considerable quantity is sold to agriculturalists as a manure for vine stocks. It is said to be a preventive of mildew and a destroyer of the phylloxera.

IV.

But the Italian asbestos industry, once so important, is already on the down grade. The difficulties of mining are very great, and unduly increase the cost of production. The asbestos itself, judged by the latest standards, is of inferior quality; it is not easy to spin, and it does not pulp well in the making of paper. The best grade is extremely rare, and its cost of mining and transportation is prohibitive. The supply from the Italian mines is rapidly falling off. As a matter of fact, Canada contains the great asbestos region of the world, in the sense, that while its mines are practically unlimited in productive capacity, the product is of a quality which fully meets the requirements of the newest and most exacting of the innumerable uses that are daily being found for it. This district lies in the Eastern Townships. It covers an area of about 200 miles in length, by 6 or 8 miles wide. Nearly the entire yield is consumed in America. Out of a total export of crude ore from the Dominion, of 3,936 tons in 1888, no less than 3,612 were taken by the United States. Since that time the output has more than doubled; indeed, it has been over 8,000 tons for the last few years. The rock carrying the marketable asbestos is generally, on fresh fracture, a serpentine of some shade of green, in which are contained numerous small particles of iron, both magnetic and chromic. The asbestos, when separated from the rock, shows a glistening, gray, dark-green surface. The fibre, which is easily separable by the fingers, is white and silky and well adapted to the manufacture of textile goods. The method of mining is entirely different from that followed in Italy. It is, in fact, quarrying, more than mining, as the face of the rock is stripped, and the cut is carried down until it reaches the asbestos-carrying serpentine, which is then removed and sent to the top of the quarry. The refuse rock, of which there is always an enormous quantity (possibly twenty or twenty-five tons to one of asbestos), is loaded into cars, run off, and shot over on to the dumping ground. The rock is passed directly into the "cobbing" sheds, where boys chip or "cob" the ore from it. The ore is then put up in bags and stacked away for shipment.

On arriving at the factory, the crude asbestos is placed under a huge roller, which instantly reduces it to a clinging mat-like fibrous mass. This is rapidly passed through a succession of sifters and separators, which tear, strip and clean the fibre until it is ready for the different departments for which it is to be graded. It is then taken up by blowers, and shot in a feathery, snow-like stream into canvas bins. Nothing more beautiful than the material at this stage can be imagined. What a few moments before was dark, sheeny rock, has been transmuted into a white, shining mass of delicate, quivering down.

V.

The process of manufacture is intensely interesting, more especially from the fact that as the industry is constantly entering upon novel phases, new methods of treatment, and special machinery have to be devised. But a description of these would carry this part of the subject to too great a length. It will suffice to say that the asbestos is graded in the bins, according to its length of fibre. No. 1, which is the highest grade, is used for carding, spinning, and weaving. No. 2 is used to some extent for carding, as well as for cement, and for pipe covering, and as a substitute for No. 1 where the material permits of a shorter fibre. No. 3 is used largely in paper, and for many kinds of filters. One of its special uses is for wall plaster. This is a new application which will have a distinct effect in modifying the practice of indoor plastering.

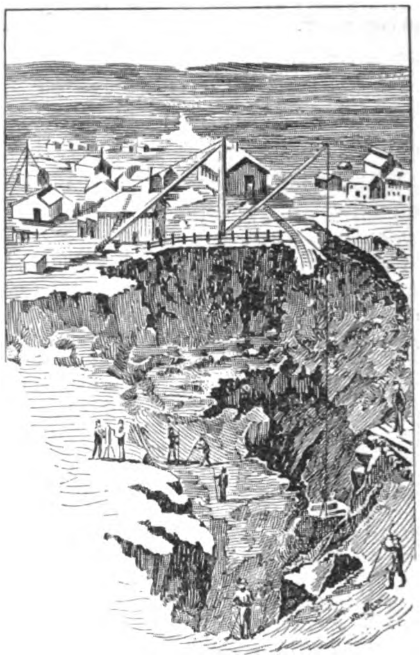


FIG. 2.—ASBESTOS MINING IN CANADA.

Instead of the ordinary tedious and elaborate preparation of studs and strips, and the use of inferior and dust-creating mortar, with its after-scoring, which is necessary to give cohesion to the final coat of plaster of Paris, a single coating of the asbestos is laid on. It has a glossy surface that will not crack, as, while firm, it is perfectly flexible. It can be put on the raw brick; and a room of which the walls have been built in the morning, can, before night, have a smoothly finished interior surface, shining like glass and hard as a rock. A kindred application of asbestos is now coming into vogue in the shape of uninflammable decorations for walls and ceilings. These are used a great deal for the saloons of steamships. They are embossed in very beautiful designs, and can be treated with gold, varnish, lacquers, or any other substance, for the enhancement of their ornamental effect.

The applications of asbestos are now so infinite that it is impossible to enumerate them here; but a few of the more important of them may be mentioned.

Firemen clad in asbestos clothing and masks, as are those of London and Paris, can walk through the hottest flame with comparative impunity. Asbestos fireproof curtains have reduced the mortality of theatre fires in a very appreciable degree. It has been calculated that between 1880 and 1890, the yearly average of persons who perished through fires in theatres, not reckoning the number of lives lost through panics, was 184. Since the introduction of the asbestos curtain, which, at a moment's notice, cuts the stage and scenery off from the auditorium, this mortality has been decreased by one-half. In torpedoes, the difficulty of dealing with the charges of wet gun cotton is overcome by inclosing them in

asbestos, the employment of which has also, in a great measure, brought the dynamite shell to its present efficiency. Asbestos is made into a cloth available for aeronautical purposes. A balloon made of this uninflammable material escapes one of the most terrible dangers to which an ordinarily constructed balloon is liable. Probably one of the first applications of asbestos in this country was to roofing. To buildings covered with this material, the shower of sparks from a neighboring conflagration involves no danger. The output is enormous. It is said that one New York manufacturer makes daily over two miles length of roofing with a special fireproof coating for this purpose. The demand for fireproof paints and coatings is continually increasing. The fact that woodwork can, by its use, be made uninflammable, has come to be an important factor in the insurance of buildings. One of the largest branches of asbestos manufacture is that of sectional cylinders for pipe coverings, for retaining the heat of steam and other pipes, felt protective coverings for boilers, frostproof protections for gas or water pipes, and cement felting, which can be laid on with a trowel, for the covering of steam pipes, boilers or stills. In some of these cases, where it is only necessary to retain the heat, the asbestos is mixed with other substances; but where the protection must be fireproof as well, only asbestos is used. The utility of such covering is well illustrated in the heating system of railway cars. The main pipe from which the individual cars draw their respective heat supplies by side mains, if not covered with asbestos, would lose a large proportion of its caloric from the rapid motion of the car through the air. An interesting innovation in this class of manufacture is asbesto-sponge. It is not generally known that sponge has great powers of fire resistance. The discovery was made accidentally not long ago, and the result was that a consignment of scraps of sponge picked up on the Southern coasts was ordered for experimental purposes. The sponge was finely comminuted and mixed intimately with asbestos fibre. The combination was found so successful for any covering which had to be fireproof as well as heatproof, that the material has become standard. Being full of air cells, it necessarily makes an excellent non-conductor. Another very extensive department in asbestos manufacture is that of packings. Of these there are an infinite number of forms. In these days of high pressures and ocean records, it is of supreme importance to marine engineers that they should have jointing and packing materials on which absolute reliance can be placed. In order to meet modern exigencies every possible form of packing has been constructed, particularly with asbestos and metallic wire, and with asbestos and rubber cores for gland packing. The making of asbestos paper varies from the building up of the thickest millboard to the production of a writing paper, which, from its indestructibility, is invaluable in case of fire for preserving charters, policies, agreements, and other important documents.

VI.

To the electrical engineer, asbestos is absolutely indispensable. Many parts of electrical devices and machinery and wires through which the electric current passes, become heated, and were it not for the electrical insulating and heat-resisting qualities which asbestos possesses, the apparatus would be completely destroyed. A form of asbestos very familiar to the electrical engineer is vulcabeston, which is composed principally of asbestos and rubber vulcanized. It is exceedingly tough and strong, dense, non-absorbent and highly resistant to heat. It possesses great mechanical resistance to blows and pressure, and is readily manufactured in the forms most useful for electrical purposes. Vulvabeston is one of the standard materials for the insulation of dynamos, motors, arc lamps, converters, street car controllers, switches, rheostats, thermostats, and many other forms of electrical apparatus. It is invaluable for the insulation of magnet spools, bushings, washers, commutator rings and sleeves, and controller parts, and for the covering of armatures.

A considerable part of an asbestos factory is devoted to weaving, the asbestos being first drawn into thread for that purpose. Here again is an apparently endless diversity. There is the fireplace curtain blower, which, with an automatic spring roller attachment, takes the place in the frame of the fireplace, of the less sightly sheet iron blower; and filtering cloths for many purposes, from straining molten metal to clarifying saccharine juices in beet root sugar refineries. A cloth is made for straining and filtering acids and alkalies in chemical laboratories. This is specially useful when the liquid to be treated is of a caustic or strongly acid nature. The filter can be thrown in the fire, and after the residual matter has been consumed, the web is as good as new. For filtering purposes generally asbestos has a unique adaptability, and in tropical countries it is held in grateful estimation as a cooler and purifier of water.

The newest departure in the asbestos field is the construction of electrothermic apparatus. The heating effect of the electric current is utilized by embedding the wire in an asbestos sheet or pad. The pad is used by physicians and nurses for maintaining artificial heat in local applications, and is said to be already largely used in hospitals. Another application of the same principle is to car heaters. A sheet of asbestos, with the embedded wires, is clamped between two thin steel plates, and the portable heater thus provided, or a series if need be, is connected to the car circuit quickly and easily. It gives an even and healthy heat and can be so regulated as not to overheat the car.

Although the list of the applications of asbestos is already bewildering, the adaptability of this marvelous product in new fields seems illimitable. In these days of scientific growth and quick resource, it is hard to foretell the scope and destiny of any great industrial innovation; but it may safely be said that the manufacture and utilization of asbestos will for many years to come constitute an industry that will occupy a leading place in the commercial history of this country.

JAPANESE STUDYING ELECTRICITY IN AMERICA.

A special dispatch from San Francisco says: Among the passengers on the steamship China is a special commission from the Mikado of Japan to study into the workings of the electrical power and telephone systems in the United States. The commission is composed of S. Mine, R. Natayama and Y. Wadachi. They spent about two weeks in examining into the telephone and electrical systems of San Francisco, Sacramento, Fresno and other cities, and then proceeded to Eastern cities. They may also visit Europe. They expect to be absent from Japan six or seven months.

"All over our empire now," said Commissioner Mine, "there is great interest in electrical power and in electrical lighting. Electricity has been introduced in several cities, but the government wants it all over the country. It is the same way with telephones. We have seen the value of them, and desire to have them generally adopted. It is our intention to study into the workings of both systems in the United States. We want to generate electricity from the many powerful waterfalls in our country, and use it for electric railways, general power and lighting.

"Wherever we can, we intend to use electricity. It will, according to the ideas of our government, be especially valuable in connection with our various public and private enterprises. It is our desire also to utilize the long-distance telephone in Japan."

MR. FRANK X. CICOTT, manager of the railway department of Pettingell-Andrews Company of Boston and New York, has sailed for Europe by the American liner New York, to be gone about two months.

LETTERS TO THE EDITOR.

THE CHICAGO SMOKE-PREVENTING FURNACE TESTS.

I am very glad to learn that my article on "Comparative Tests of Smoke-Preventing Furnaces," in your issue of March 11, has proved to be of interest to some engineers, as shown by the letter of Mr. C. Doutre, E. E., in your issue of April 8, making inquires concerning the tests.

In reply I would say that on these tests the feed water was not taken from our heater, which delivers the water at a temperature of between 200 and 210 degrees Fahrenheit, on account of the sudden and varying demand for water in the weighing tanks having a tendency to derange the automatic system by which our heater is supplied with water from the hot well. The temperature of the hot well was also lower than usual on account of the small number of engines in service during the tests, the level in the hot well being kept constant by cold water from a valve operated by a float. This low temperature, however, has no effect on the evaporation from and at 212 degrees Fahrenheit, as, of course, the temperature of the feed water was taken into consideration in figuring this.

In regard to the consumption of coal per horse-power per hour, this is per boiler horse-power, of course; if it were figured per engine horse-power it would be a little less than two pounds per horse-power per hour. With this low grade of fuel the cost per horse-power per hour should be considered rather than the weight.

I hope that the above will throw some light on the points raised by Mr. Doutre.

B. R. T. COLLINS,
Engineer of Tests, Chicago Edison Company.

Chicago, Ill.

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CONTENTS.

ELECTRICITY AND COMPRESSED AIR.

IT is a well established fact that certain ideas in the arts recur in cycles of greater or less period, and one of these is the application of compressed air for motive power purposes generally. It would be rash to deny that compressed air has rendered valuable service in many ways in the past, and that it has still a large field of usefulness, but it is to be regretted that after the long years of experience had with compressed air it should still be put forward by some as an agent for the accomplishment of work for which modern methods have long been demonstrated to be better adapted. As an instance of this character we may recall our recent remarks on a paper read before the American Society of Civil Engineers, in which the author gives it as his opinion that compressed air will be found superior to electricity for power transmission, whether the distance be a thousand feet or twenty miles. We need not trouble ourselves about statements of this character at this late day, but it would appear that compressed air is again being put forward as an active competitor to electricity for street railway work, and it is rumored that the Madison avenue car line in New York City, which has been acquired by the Metropolitan Traction Company, is shortly to be equipped with compressed air motors.

Disregarding for the moment the ulterior reasons that may have dictated this step, there can be little doubt that, considering efficiency alone, compressed air motors cannot compete with electricity directly conveyed by conductors to the car, or by means of storage batteries carried on the car. In the present instance it is proposed to use air compressed into tanks at 2,000 lbs. What the losses would be in such a system is well brought out in the short analysis by Mr. Robert Lundell, which appears on another page. Compressed air as a motive power seems so alluring that many are carried away by it and some recent writers have done much to foster the rosy views which many have held in the past and upon the strength of which many thousands of dollars have been sunk in fruitless attempts. One of the recent writers on this subject is Mr. W. P. Pressinger, who in "Cassier's Magazine" for June, describes the salient features of the latest compressed air street railway motors. Mr. Pressinger devotes considerable space to describing the Hardie motor and the report made thereon by Captain Fiebeger, of the Corps of Engineers, U. S. A. Captain Fiebeger's report is open to many criticisms when viewed from the standpoint of standard street railway traffic. To begin with, the experiments were made with a motor mounted on the tracks of the New York Central Railroad, which statement in itself would be enough to cast a shadow of doubt on their value as a criterion for regular street railway practice, as it is well known that under the normal condition of street railway tracks they call for the consumption on an average of twice the power required for free T-rails which keep clean automatically.

Another advantage claimed for the compressed air motor is that "the weight is spring supported, while in the electric motor the weight of the motor is rigidly attached to the axle." We are afraid that Captain Fiebeger is not thoroughly informed as to the more modern methods in electric railway practice. We could name several electric motors which do not rest on the car axles. While it is true that a large number of this type are still in use it is only a question of time when they will disappear. We are also told that electric cars require an excessive power in the motors from the fact that two motors are employed which do not work synchronously. This criticism brings up the old question as to the power required to drive electric cars. Beginning with two 7½ horse-power machines, used by Mr. Sprague in Richmond, the power has gradually increased until the present normal equipment is two 25 horse-power motors to each car. No one acquainted with street railway practice need be told that an ordinary street car, when running at speed, requires anything like the full capacity of its motor equipment, but some writers on the subject fail to

fully grasp the fact that the substitution for electricity has created a demand for higher speed than the horse was able to furnish. If the public would be satisfied with a slow, gradual start, permitting the car to reach its normal speed within the space of a block, one-half the motor equipment now applied would be ample; but unfortunately such is not the case. The motorman who does not now bring up his car to full speed within three or four car lengths could not maintain schedule time, and would in all probability lose his position. These conditions exist, no matter what the nature of the power applied, at least so far as this country is concerned. It is hardly fair to compare foreign practice to that of the United States on these lines. Abroad cars are considered fully loaded which we consider half full. In addition, the public abroad is quite satisfied with speeds such as would not be tolerated by the American public. As a consequence, the power consumed by cars operated by compressed air abroad must be largely modified when applied to conditions existing in the United States.

With all these facts before us, we cannot believe that the Metropolitan Traction Company, even if it installs the ten or dozen compressed air cars on the Madison avenue line, intends to employ this system generally for its new work in New York City. We do not, in fact, look upon it as an experiment in the true sense of the word, but venture to believe that it is rather a device to gain time, pending further investigation for the introduction of electricity. As our readers are aware, several cars operated by storage batteries have been operated on this line during the past winter. At the same time the Metropolitan Traction Company has had an opportunity to study the workings of the Lenox avenue conduit. The latter, we understand, has not given entire satisfaction, but the defects, such as they are, we believe, can be remedied. On the other hand, other underground systems, several of which are now in practical operation both here and in Washington, will afford ample opportunity for observation, and when the time comes for actual work we have no fear but that electricity in one form or other will be adopted as the motive power.

ALTERNATE CURRENT ARC LIGHTING.

THE demand for systems of electrical distribution that shall be sufficiently flexible to operate any kind of load from the mains supplied by one type of generators has led within the last few years to some remarkable modifications, especially in the field of alternate current working. The use of arc and incandescent lamps and motors from the same current supply is perfectly feasible and in common every-day practice in direct current stations, but in alternating current stations the problem in regard to arc lighting may be said to be still in a somewhat unsettled condition, although such stations are supplying arc lamps which require the use of more or less inefficient devices. The use of the old direct current, series machines was almost universal for arc lighting until very recently, and probably more than 90 per cent. of the public arc lighting in this country is still done with series machines. The use of two or more kinds of machines in a station is incompatible with the highest economy, and as it is apparent from experience that any successful station must be prepared to supply current for all purposes, the old line of series machines will gradually disappear, as they already have to some extent on direct current constant potential systems.

One method of supplying arc lights from alternating stations is to run a special arc machine from a synchronous motor connected to the alternating circuit. This is evidently an inefficient method. Another is to run alternating current arc lamps from a transformer, either one or several lamps to one transformer. Another method for alternating current stations is arc lighting by means of rectifiers, which method has come into use in England during the last three or four years, although the principle has been known since the earliest time of arc lighting. The first arc lights used in the French lighthouses were run from alternators fitted with commutators, and this is practically rectified current arc lighting. The result of some efficiency tests with rectifiers and alternators has been found to be as high as 80 per cent. for a 55-light unit, which is considerably higher than was obtained from a direct current machine of the same capacity in a comparative test. But sixty lights appears to be the limit to which rectifiers have reached and even with this size there is heavy sparking at the commutators. This size, however, will hardly satisfy the conditions of American practice, as both economy and convenience demand the use of units of double this size in many places. Arc lamps when used with rectifiers also require some modifications in design, as the regulation is more sluggish than with direct current arcs. While this solution may be of advantage in special cases, it does not appear to meet the requirements of a series circuit of 5,000 or 6,000 volts, which is frequently necessary in lighting outlying districts economically. The most satisfactory solution of this alternate current problem would probably lie in the production of a series alternating arc lamp whose luminous efficiency would reach that of the continuous current arc.

DRAWBAUGH AGAIN.

IF persistency be a virtue, then the palm for this valuable faculty must be awarded to Mr. Drawbaugh and his associates. One would have supposed that a decision of the United States Supreme Court would suffice to put an end to all claims and disputes, but evidently Mr. Drawbaugh and his coadjutors believe otherwise. As noted on another page, the Senate Committee on Patents last week made a favorable report on a bill for the relief of Drawbaugh, so as to permit the issuance to him of his original patent applications of some fifteen years ago, for the microphone transmitter, etc. These Drawbaugh patents cover practically the main principles used in all modern telephonic apparatus, and if the bill be allowed to pass and the patents to issue, they would occupy practically the same ground now covered by the governing patents owned by the American Bell Telephone Company. It is true that the bill grants immunity to all users of telephonic apparatus prior to the proposed issuance of the Drawbaugh patents, but this proviso must, of course, cut a very small figure in the end. The issuance of these patents would at once place the American Bell Telephone Company again in a position where it would have to fight for existence, and if we may judge by the past, it will enter the fray with a light heart. Viewed from the standpoint of the public, however, the issuance of these patents to Drawbaugh would create another monopoly, which would without doubt be even more distasteful than that of the Bell company, and if we mistake not the country is in no mood for the granting of further privileges in this field. Indeed, the whole proposition embodied in the proposed bill for relief to Drawbaugh strikes us as being too preposterous to require any serious consideration.

THE HORSELESS VEHICLE COMPETITION.

THE competitive test of horseless vehicles which took place in New York on Decoration Day cannot fail to leave the impression that considerable remains to be accomplished before this style of locomotion can supersede the horse as a motive power. There were no electric carriages in this exhibition, and, so, as far as this special test is concerned, no comparisons can be drawn between electricity and the gasolene and other liquid fuel engines, which took part in this event. But it is noteworthy that the engine-driven vehicles which were in this competition, with but one exception, returned from the trip to Irvington in a more or less dilapidated condition.

Electric Lighting.

THE CONTROLLABLE JUNCTION BOXES AND FEEDER SWITCHING SYSTEM OF THE NEW YORK EDISON CO.

WHILE the extended description of the stations of the Edison Electric Illuminating Company, of New York, which appeared in our issue of January 8, gave the salient features of the work of that admirably equipped organization, many interesting details were of necessity omitted for lack of space. Indeed, to have dwelt even briefly on all the numerous smaller, secondary operating methods and apparatus would have involved the writing of a respectable volume, instead of the comparatively few pages which formed the limits of our article. Nevertheless, some of these smaller details have important influence on the economy of operation, and one among these, which has been found to work particularly well in p[illegible] is the system of controllable junction boxes, which m[illegible] possible to switch underground circuits together, or apart, by switches located at the stations. The system of employing these controllable boxes is due to Mr. R. R. Bowker, first vice-president of the company, who devised the general plan, and Mr. John Van Vleck, its constructing engineer, who invented the mechanism of the special junction boxes, and as it has a general and useful application, we have deemed it well to describe it in some detail.

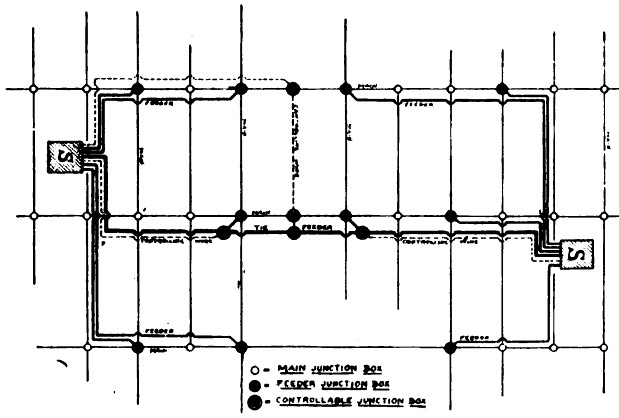


Fig. 1.—The Bowker Feeder Switching System.

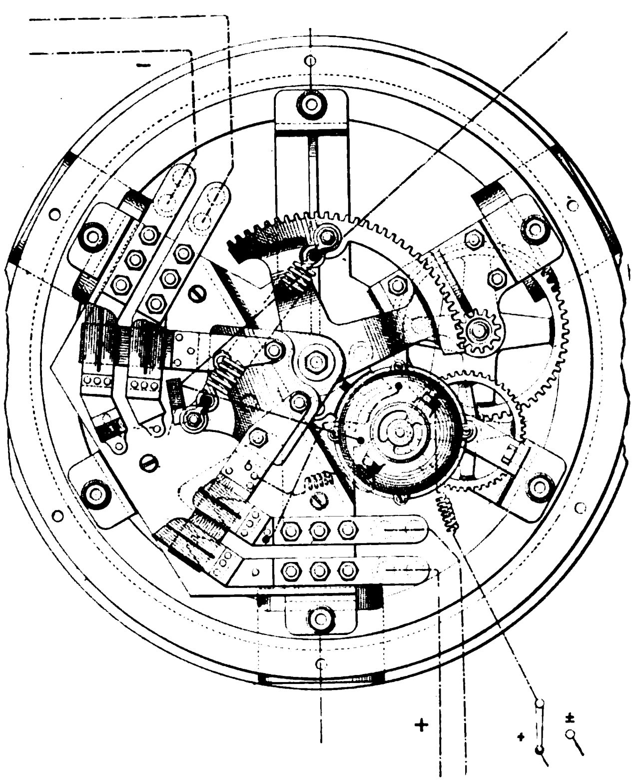


Fig. 2.— [T]he Van Vleck Controllable Junction Box.

The most important of its functions consists in the insertion of controllable boxes in the line of a tie feeder between two stations, so that when the tie line is not used as a means to transmit energy directly from one station to another it can be connected at will to one or more points of the distributing system of mains, thus enabling the tie feeder, that would otherwise lie idle, to be used as a regular distributing feeder in each direction from both stations.

Another application consists in the insertion of the controllable boxes directly in the lines connecting one district with another, which districts might each be supplied by separate stations; in this way one district can easily be electrically separated from the other in case it should become desirable to make such a disconnection.

The above applications can perhaps be better understood by referring to diagram, Fig. 1, which shows two branch disconnective boxes inserted in a tie feeder, one box being controlled from one station and the other box from another; but the boxes as made can both be controlled from one station if desired.

The diagram also shows straightway disconnective boxes inserted in the mains connecting the two districts supplied by separate stations and also in the tie feeder connecting the two stations; these boxes can, if desired, all be operated from one of the stations, or they can all be operated separately if desired.

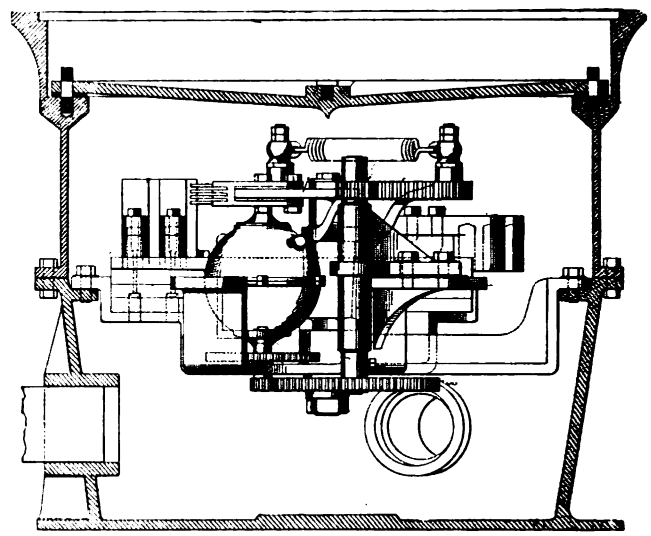


Fig. 3.—The Van Vleck Controllable Junction Box.

A further application consists in switching feeders or mains on at particular points of the system at certain times when an increased supply of current might be needed at one place and not at another, as, for instance, the charging of storage batteries located at a distance from a generating station, when such charging might make it desirable to charge at night from certain feeders that would otherwise be employed at the time of maximum load.

The various applications of the box are, in fact, quite numerous, and it is expected that the use of controllable boxes will materially assist in the economical and satisfactory distribution of low tension energy.

The details of the box itself, are illustrated in two views in Figs. 2 and 3, and its principle will here be briefly described. The box is constructed so as to break or switch apart a straight line running through it; or else, it can be made to break a branch line emanating from it. In either case, the box contains a double-pole knife blade switch which is operated by a 1-6 horse-power Lundell motor inclosed in the box. The field of the motor is connected constantly in one direction across 120 volts, while one end of the armature circuit is connected to one of the movable switch blades, the other end being connected to a two-way switch placed at the station or some other point of control. The connection is made by employing a convenient pressure wire that might otherwise be used as a neutral pressure wire, and, therefore, not necessary for the reading of pressure.

On throwing the two-way controlling switch in the station an opposite potential is thrown across the armature, which causes the motor to revolve, opens the main switch in the box

and the blade connected to the box end of the armature circuit is brought in contact with a terminal of the same potential as that of the other, or station, end of the armature circuit, thus bringing the armature to rest.

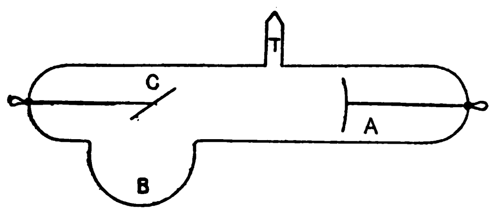
When it is desired to reconnect the box, the two-way switch in the station is thrown over, so as to bring an opposite potential again across the armature circuit with a reversed polarity, so that the armature is caused to revolve in an apposite direction, and the main switch in the box is closed. This operation can, of course, be repeated any number of times.

By connecting lamps or a galvanometer in the circuit of the controlling pressure wire at the station, an indication will be given as to whether the motor has operated, so that no doubt will exist as to whether the switching operation in the box has been successfully accomplished.

It might be of interest to note that one of these boxes has been successfully operated over 8,000 times in order to establish the general reliability of the mechanism.

AN IMPROVED CROOKES TUBE.

Of all the forms of tube that we have tried, say Messrs. Hutchins and Collins, of Bowdoin College, in the "Scientific American," the one shown in the annexed diagram is the most effective. Here the anode, C, is an inclined plate of thin platinum. This is placed at or beyond the focal point of the cathode, A. This piece of platinum becomes red hot, and is, as far as can be judged, the source of the ray. It is a curious fact that the anode, C, if made in the form of a thin plate, may nearly fill the tube without in any way obstructing the passage of the rays out at the bulb. The bulb is filled with an intense green fluorescence, and sparks can be drawn from it by approaching the finger.



Novel Form of X-Ray Tube.

Not only do these tubes give remarkable results in the way of intensity of rays, but also extremely fine definition.

The cellular structure of the bones is clearly brought out and the course of the tendons can be traced along the arm. Good pictures of the bones of the fingers can be obtained in from five to thirty seconds, and of the hand and wrist in from one to ten minutes.

X-RAY TUBE PHENOMENA.

Writing on his work with X-ray tubes in "Nature," Mr. J. W. Gifford gives the following experience:

"At one of my demonstrations two tubes failed to act. They were both of the kind which depend for their action on a piece of platinum placed within, and from which after bombardment by cathode rays the Röntgen rays take origin. A glance at the tubes showed that owing to the unusual strength of spark the platinums within them were red-hot at the point of impact. Before the demonstration the tubes had been in good working order. I considered they had broken down, but, on returning home, tried them with the spark from my own apparatus, with which they had before answered well. I was somewhat astonished to find them giving off Röntgen rays rather more freely than when first tried. This tends to show that Röntgen rays are not given off by platinum heated above a certain temperature. I think this has already been suggested, but I have not seen it corroborated.

"Following up the idea of reinforcing the effect of the Röntgen rays by placing a fluorescent screen under a sensitive film on celluloid, the celluloid side being next the screen to prevent 'grain,' and having tried screens of barium platino-cyanide, potassium platino-cyanide, calcium tungstate, natural scheelite, artificial scheelite (Edison's), fluorspar and calcium fluoride, I find that potassium platino-cyanide and artificial scheelite alone produce any effect through celluloid. Barium platinocyanide, placed underneath, gave no effect either in contact with the sensitive film itself or through celluloid, but the films were not sensitive to yellow, and this salt gives yellow fluorescence. The effect with potassium platino-cyanide was decidedly the best."

THE ACTION OF ROENTGEN RAYS AND ULTRA-VIOLET LIGHT ON ELECTRIC SPARKS.

In a recent number of the proceedings of the Accademia dei Lincei, Messrs. Sella and Majorana describe a series of experiments on the above subject, of which they give an abstract in a letter to "Nature:"

"We had formerly found that the sparking distance between two electrodes, in a shunt-circuit on the discharge of an induction coil, which illuminates a Crookes tube, is strongly diminished if the Röntgen rays sent from the tube fall upon the positive electrode. The phenomenon is very interesting, as it is the reverse of the phenomenon discovered by Hertz, in which the ultra-violet light acts on the sparking distance in lengthening it when falling on the negative pole. On subsequent experiments, we found that when the sparking distance was the same as that used with Röntgen rays, the ultra-violet light acted exactly in the same way, and the passive pole—so to say—was then the positive one.

"So far we had succeeded in reversing the phenomenon discovered by Hertz, and further investigated by Wiedemann, Ebert, Elster and Geitel, and had shown the parallelism of the two radiations as to their impeditive action on the spark. But on diminishing the sparking distance, when the ultra-violet light has a facilitating action, we have shown that the Röntgen rays would provoke the passing of the spark. In the last case the passive pole—i. e., on which the radiation must fall—is in both cases the negative.

"So taking as electrodes two spheres of amalgamated brass, 52 mm. in diameter, when the sparking distance was below 30 mm., the Röntgen rays and the ultra-violet light provoke the passing of the spark when falling on the negative electrode. When, on the contrary, the distance was more than 30 mm., both radiations act in an impeditive way when falling on the positive pole."

AN X-RAY METER.

The peculiar glow exhibited by a "focus" tube working well furnishes a good criterion of efficiency as regards Röntgen rays. A more definite means of comparing the actinic power of the radiation has been produced by Messrs. Reynolds and Branson, Leeds. A small quadrant of aluminum is constructed in concentric terraces, ranging from one millimetre to ten millimetres in thickness. By holding this quadrant between an excited Crookes tube and a phosphorescent screen, the thickness of aluminum which the rays are capable of traversing can be seen upon the screen; or, by substituting a sensitive plate for the screen, the effect may be photographed. The "X-ray meter," as the quadrant is called, thus furnishes an easy means of comparing the intensity of Röntgen rays emitted by different tubes and by the same tubes at different times.

LORD KELVIN ON LAMPS.

Lord Kelvin has been giving evidence before the House of Commons Committee on the question of the Petroleum Acts in connection with the public safety. He thinks the sale of paraffin for ordinary use of a lower flashing point than 130 degrees, open test, ought to be prohibited by law, but does not think it would be wise to introduce legislative restrictions on the manufacture and sale of lamps. In fact, so far as the petroleum lamp is concerned, he despairs of introducing safety by legislation. It seems that the most dangerous lamps are not in poor houses, but in fine drawing rooms. Some of those on tall stands with large crystal reservoirs would make a very bad accident if they fell over. On a balance of evils, Lord Kelvin prefers metal to glass reservoirs, but jokingly suggested that the ideal would be an aluminum reservoir with a Röntgen ray to see inside of it.

ELECTRICAL DISPLAYS AT MOSCOW.

The electric illuminations of the Kremlin are reported to have been a great success. Some interesting particulars as to the preparations for the display appeared recently in the "Novo Vremya": "Electricity will be freely called into play. For several months past military electricians and sailors have been actively employed in fixing electric lamps on the tower of Ivan Veliki and other buildings in the Kremlin; 6,000 lamps are arranged outside that tower, 10,000 more on the walls of the Palace fortress, and 8,000 on the arsenal and barracks.

The electric wires that will supply these 24,000 lamps are ten versts in extent. There will also be 200,000 colored lamps lit by oil, while the façade of the Kremlin facing the Red Square will be illuminated by means of gas. The Tainitskaia tower will be transformed into a cascade lit up by electricity, the water falling the whole height of the tower on to the quay of the river."

X-RAYS WIN A DAMAGE SUIT.

X-rays have recently won a damage suit in England in a case which Miss Gladys Ffolliett, an actress, brought against the Nottingham Theater Company. The plaintiff alleged that she had injured her foot because of a faulty staircase in the theater. When the defendants denied this Miss Ffolliett had the bones subjected to X-rays by Professor Ramsay, produced the result in court, and the jury decided in her favor.

THE SCHNABEL LAMP.

Mr. Rudolf Schnabel, of Dresden, has written to the "Elektrotechnischer Anzeiger" to say that he has discovered a new material which will be of great service in electric lighting work. No details are given as to the constitution of the material, but it appears to be a powder. The weight used is a quarter of a gramme, and the price of it $1.50 a kilogramme. The lamp takes the form of a marble slab, with a groove and a shallow cavity to receive the powder. Carbon leads are used. It is stated that sixteen watts (four amperes at four volts) give a power of twenty candles; that the light is whiter than that of an incandescent lamp, but contains more yellow than violet rays. The temperature of the incandescing material is such that iridium wire at once melts and is vaporized within three or four minutes. Editorially, the "Elektrotechnischer Anzeiger" points out that the new lamp claims an efficiency of .8 watt per candle as compared with 2½ to 3 watts for an ordinary incandescent lamp, and makes the obvious remark that a low-potential lamp of this kind could not be used in parallel on any existing systems. It is added that the discovery of Mr. Schnabel will be one of far-reaching importance if the particulars given above can be maintained; the life of the lamp is reasonably long, and the cost of installation not too great. The result of trials of the lamp is still to be awaited.

PERSONAL.

MR. T. C. MARTIN, editor of The Electrical Engineer, left on Saturday, June 6, by the "City of Rome" for Glasgow, where he will represent, by appointment, the American Institute of Electrical Engineers and the National Electric Light Association at the jubilee of Lord Kelvin, as Professor of Natural Philosophy in the University of Glasgow. On June 19 Mr. Martin is to lecture by invitation before the Royal Institution in London, on the Electrical Utilization of Niagara.

MR. E. A. BARNES, of the Fort Wayne Electric Corporation, seized the opportunity to attend the exposition and at the same time look up old acquaintances in New York during the last two weeks.

OBITUARY.

HENRY C. CRANSTON.

Henry C. Cranston, banker, and president of the Providence Telephone Company, died suddenly last month, aged 70 years. He had charge of the first telegraph office in Providence, and later was attached to the Mexican Boundary Commission. In 1864, after having been in the employ of the Providence National Bank for several years, he embarked in the banking business for himself. He was actively interested in the development of the telephone service in Providence.

LITERATURE.

COX'S PULLEY AND GEARING COMPUTER, Cox Computer Company, New York. Price, $1. This is a very handy device for computing the sizes of pulleys and gearing when the number of revolutions, diameter, or number of both gear teeth and belt speed are known. The computer is accompanied by full instructions as to its use. It makes a very handy folder, printed on stiff cardboard.

TELEPHONY AND TELEGRAPHY.

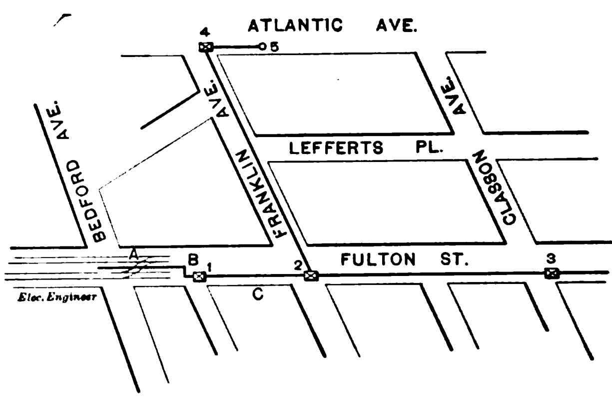
MANHOLE EXPLOSIONS AND THEIR REMEDY.

BY A. E. DOBBS.

EXPLOSIONS occurred in four manholes of the New York and New Jersey Telephone Company's system in Brooklyn about May 1, and in each instance manhole covers weighing from 400 to 700 pounds were blown out. In one case a cover weighing 600 pounds was thrown as high as the elevated railroad structure, against which it was broken. The explosions occurred at Classon avenue and Fulton street, at Franklin and Atlantic avenues, at Franklin avenue and Fulton street, and at Fulton street and Bedford avenue.

The part of the occurrence of interest to electrical men is the cause of the explosions and what means can be taken to prevent them. The cause of the explosion was easily found. Fulton street in this section is being repaved and the trolley companies are also taking advantage of this to make repairs on their tracks. At Fulton street and Bedford avenue a temporary crossover had been put in to enable the cars to cross from one track to the other. At the same place the telephone cable—104 conductors lead covered—is hung midway between the two tracks upon the elevated railway structure, which is also used to support the trolley wires as well as electric light wires. Where the crossover had been put in, A, of the accompanying diagram, a pole was swung from one track to the other in close proximity to the telephone cable. Conductors, when crossing this switch, had been warned to pull down the trolley pole, but one of them forgot it and a bent trolley pole made contact from the wire to the cable, and of course as there is always a little gas in the manholes which had been increased by the disturbance of the streets, an explosion followed.

At the point marked B the cable leaves the elevated structure and goes into the underground ducts through an iron pipe.



The pipe lies loosely against an iron pillar and is not in good contact with it, as was proved by the fact that an arc had been formed, which, judging by appearances, must have taken at least five amperes, thus showing the resistance between it and the elevated road to be about 100 ohms.

As the cable where it entered the pipe was insulated from it by means of rubber hose, etc., and the pipe doubtless painted on the inside, it requires no shrewd guessing to suppose that considerable of a spark passed from the cable to the end of the pipe in the manhole.

But this iron pipe only took care of five or six amperes and considerably more than this must have come from the trolley cross.

From the point 1 in the diagram the cable goes to the other manholes in creosoted wooden ducts, which are a very good insulator for such heavy currents, even though they do ring grounded to a magneto. At manhole No. 2 the cable divides, part of it going to No. 3 and part to No. 4. At manhole No. 2 also there are several cables with well-soldered connections all bound together with a copper wire, but they were not grounded in this manhole except that the copper wire used for connecting them together was lying loosely against a gas main. One of the cables was also in loose contact with this gas main, just close enough to make a good spark if there were several hundred volts potential between the pipe and the cable, as there undoubtedly was, for this cable was not grounded except for the light ground it got from the wooden ducts, while the gas pipe was well grounded, and lying in such close proximity to the tracks, was probably connected to them also.

From 2 to 4 the cable was also laid in creosoted conduit, but from 4 to the junction pole an iron pipe was used, and the difference of potential between this and the comparatively weak ground on the cable must have been considerable. There were very faint traces of an arc between the cable to the pipe, but with the potential carried one-fifth of an ampere would be enough for this.

The Fault.—This cable, though strung for some distance under the elevated structure, was carefully insulated from it and the only grounding the cable received was from the creosoted ducts and from other cables similarly situated. In the aggregate, of course, the ground was very good for weak currents, but the potential difference between different parts of the system must greatly facilitate electrolysis.

The Remedy.—When it is necessary to ground a cable or conductor, the work cannot be too well done. Make the connection to gas or water pipes in its immediate vicinity so thorough that there can be no more than one volt potential difference between them and the cable.

When cables are strung under the elevated roads, connect them to the suspension wire every thousand feet. Had this plan been followed in the above case the current would have been largely shunted to the elevated road instead of into the manholes, and had the cables been grounded at the manholes as already suggested there could have been no spark. Moreover, the season for thunderstorms is approaching and it requires no expert guessing to anticipate still more of these explosions.

Again, if a cable must be insulated, as in creosoted conduits, see to it that the insulation is maintained. If you have the cable laid in wooden ducts do not change from these to iron pipe, or if you must use iron pipe see that the cable is wrapped with something like tarred cloth or rubber hose that will insulate it. If this plan had been followed in Brooklyn the current would have distributed itself so gradually that there would not have been a spark at any one point. In the above case, also, if there are gas, steam or water pipes in the same manholes, see to it that the cable does not touch any of them.

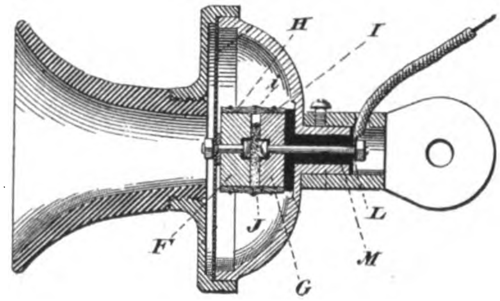
It might also be pertinent to suggest right here that perhaps manhole coverings could be made with openings that would allow the gas to escape and the bottom of the manhole to be drained into the sewer. Of course a great deal of dirt would get into a box of this kind and the Board of Health might object to the gas, but the dirt could be cleaned out once or twice a year and the gas would probably not escape in quantities large enough to be objectionable. It is but just to the engineering talent of the N. Y. and N. J. Telephone Company to say that these conduits were built long before the trolley lines were erected, and that all this trouble with electrolysis and manhole explosions could not well have been anticipated.

PROTECTING TELEGRAPH AND TELEPHONE WIRES FROM TROLLEY CONTACTS.

AN article in the "Elektrotechnische Zeitschrift" describes an apparatus tried on the Zwickau Electric Railway, in Germany. The trolley wires of the up and down lines of the railway, where they are crossed by telephone and telegraph wires, are protected by guard wires running parallel to the trolley wires and at some distance above them. In most cases of fallen wire this would be sufficient to prevent a contact, as the fallen wire would hang in bights from the guard wires and would be well clear of the trolley wires. If, however, the breakage occurred close overhead so that there was a loose end to be dealt with, this would not be the case, since the loose end would hang straight down from the guard wire to the tram wire, and if it fused there is nothing to determine at which point it would go. Moreover, under the influence of the wind or anything causing the loose end to swing, there would be the contingency of momentary contacts occurring of a very troublesome character. In the Zwickau arrangement the two guard wires are connected by a cross span wire which goes to the coil of an electromagnet and thence to the rails, constituting the return of the railway circuit. A wire also goes from the overhead trolley wire to this, the earthing wire, at some point between the electromagnet and the rails. This wire, of course, puts the trolley wire to earth, and the circuit is accordingly broken in the neighborhood of the electromagnet. When, however, the latter is excited and attracts its armature, this latter releases a falling piece, which completes the circuit. Any slight current from the telegraph or telephone wire would be too weak to affect the armature, but even a momentary contact, which sends the heavy current of the trolley wire through the short length of fallen wire to the guard wire and thence to the electromagnet, at once puts the trolley wire to earth until some one comes along and replaces the falling piece. It is stated that the trials made at Zwickau proved exceedingly satisfactory.

SUTTON'S MICROPHONE TRANSMITTER.

THE accompanying engraving illustrates a novel form of telephone transmitter invented by Mr. George W. Sutton. The talking parts of the telephone are inclosed in a case of the usual pattern. The variable pressure parts, shown in cross section, comprise a pair of carbon buttons, F G, which are placed opposite each other. These are surrounded by a sleeve or envelope of cloth, H I, whose edges are frayed. The edges serve to keep the buttons a small distance apart to form a chamber, J, which contains granular carbon. One of the buttons, F, is carried on the diaphragm, being electrically connected to it by a screw whose head is insulated from the button. The other electrode is supported on a metallic bolt, L, which passes through it. The bolt is surrounded by an insulating sleeve, M, set in the back of the casing, and constitutes one terminal of the telephone, while the casing itself is the other terminal.



THE SUTTON TRANSMITTER.

The object of this invention has been to produce a delicate, easily adjusted telephone, which would be suitable for either short or long distance working.

A BILL FOR THE RELIEF OF DRAWBAUGH.

On June 3 the Senate Committee on Patents, by a vote of 4 to 3, made a favorable report on the bill for the relief of Daniel Drawbaugh. This bill directs the Commissioner of Patents to issue to Daniel Drawbaugh a patent or patents for the inventions of improvements in telephony described and claimed in pending applications filed by Drawbaugh in the Patent Office at various times from 1880 until 1884, notwithstanding that said inventions may have been in use or on sale for more than two years prior to the date of the filing of Drawbaugh's original application of July 26, 1880. These patents, when issued, are to have the same effect as though no delay had occurred in presenting or prosecution therefor, and each patent when so issued is to be good in law to secure to the owner the sole right during its term to the exclusive use, make, and sale of such patent invention. A proviso gives all persons having apparatus containing any of these inventions in use at the time of issuing such patent the right to continue the use of such apparatus without charge or molestation; and no one is to be liable to Drawbaugh for any manufacture, use, or sale of Drawbaugh's inventions occurring prior to the issuance of the patent or patents authorized in the bill.

In an interview, Mr. J. R. Bartlett, president of the Drawbaugh Telephone and Telegraph Company, is quoted as follows:

"It will permit the issue to Drawbaugh of fundamental patents for the microphone, thereby transferring the control of the long distance telephone from the Bell company under the Berliner patent to the Drawbaugh company. The public will not be burdened by an extended control of the telephone, as the Berliner patent now covers the forms of telephone embraced in the bill, and this Berliner patent is owned by the Bell company. The Government has a suit pending to cancel it upon the ground of fraud. Drawbaugh's priority in the invention of the telephone has long been known and abundantly established, and the Government has a second suit pending against the Bell company in which this priority has been plainly demonstrated. Drawbaugh has been prevented from obtaining these fundamental patents only by a slight technicality, which was set up against him through the influence of

the Bell company, and it is to relieve Drawbaugh of this technicality that the present bill has been introduced. Opposition was made before the Senate Committee on Patents by the counsel of the Bell company, and an exhaustive argument was presented to show that Drawbaugh was not entitled to any consideration, but the merits of his claims were so apparent that the Patent Committee reported the bill favorably. The Bell company has enjoyed many years of prosperity, based on the rights belonging to another, but Congress has at last undertaken to right this wrong by the enactment of a law, which, while moderate and reasonable in its terms, will secure to Daniel Drawbaugh the rights that belong to him."

CONSOLIDATION OF INDEPENDENT TELEPHONE COMPANIES.

Representatives of thirty independent telephone companies doing business in Eastern Ohio, West Virginia and Western Pennsylvania, met in Pittsburg on June 3 and consolidated under the name of the Interstate and Local Telephone Association, for the purpose of competing with the Bell Company. The several companies represented a capital of about $750,000, and have over 10,000 instruments in use. D. C. Ogden, of Greensburg, Pa., was elected president of the new company; A. V. Diveley, Altoona, vice-president; Burt Hubbell, Pittsburg, secretary, and D. D. Jamieson, New Castle, Pa., treasurer. The new company proposes to furnish telephones to subscribers for less than half the Bell Company's charges.

REPORTING OF THE ST. LOUIS CONVENTION.

Preparations for handling the telegraphic reports of the St. Louis Convention are unusually complete. The Western Union Telegraph Company has assigned its most expert operators from the various large offices throughout the country to the convention work, and the wire facilities will be ample for any emergency.

There will be one change in the telegraph service in this year's convention. The telegraph companies, at the solicitation of the newspapers, will send out no bulletins from the Convention Hall until balloting begins. After that they will simply announce the result of the ballots.

EDUCATIONAL.

THE ROSE POLYTECHNIC.

The Rose Polytechnic Institute, of Terre Haute, Ind., has just issued its fourteenth annual catalogue containing the courses of study and plan of instruction. A separate illustrated catalogue is issued for the department of electrical engineering, showing views of the electrical laboratory, standardizing room, a portion of the generating plant and the machine shop of the Institute. The course in electricity commences in the middle of the sophomore year and throughout the course the work is largely done in the laboratory. Together with the study of the theory of electricity, comes the practical experimental verification.

The carrying on of this course requires the provision of a complete equipment of instruments of precision for investigational work, and other appliances for practice in technical operations, all of which are to be found in its well equipped shops and laboratories.

BROOKLYN INSTITUTE, DEPT. OF ELECTRICITY.

The members of the department of electricity of the Brooklyn Institute held their annual meeting in the Art building on May 19, and elected officers for the ensuing year: President, James Hamblet; vice-presidents, William S. Barstow and J. P. Wintringham; secretary, Henry T. Weed. The lecture of the evening was delivered by Dr. Charles E. Emery, the recently elected president of the New York Electrical Society, and president of the institute department of engineering. Dr. Emery's subject was, "The Electrical Transmission of Energy," and the lecture was devoted to showing the economic status of the electric current in doing work at points near and remote from the source of energy.

EDUCATIONAL OPPORTUNITIES AT WORCESTER POLYTECHNIC.

In the interests of your readers, will you kindly note the fact that, by recent enactment of the State Legislature, twenty new free scholarships in the Worcester Polytechnic Institute become available to the next entering class? This makes forty free scholarships, in all, available, being one for every Senatorial district in the State, in addition to the twenty-five or thirty free scholarships to which students from Worcester County only are eligible.

T. C. MENDENHALL,
President.

MECHANICAL.

THE RAWORTH UNIVERSAL HIGH SPEED ENGINE.

THIS engine, designed by Mr. J. S. Raworth, and built by the Brush Electrical Engineering Company, of London, a general view of which is shown in Fig. 1, is essentially a tandem engine, and is built either simple, compound, triple, or quadruple expansion, according to the requirements of the load. The cylinders are placed in pairs, one above the other, and the valves, which are of the Corliss type, are placed between the cylinders. The high pressure valve is distinct from that on the low pressure side.

The high pressure presses on the under surface of the upper piston, and the expanded steam from the receiver presses on the upper surface of the low pressure cylinder. During the down stroke to the point of cut-off the receiver and high pressure cylinder are in communication with the low pressure cylinder, the two former being arranged so that their difference in steam pressure shall be very small.

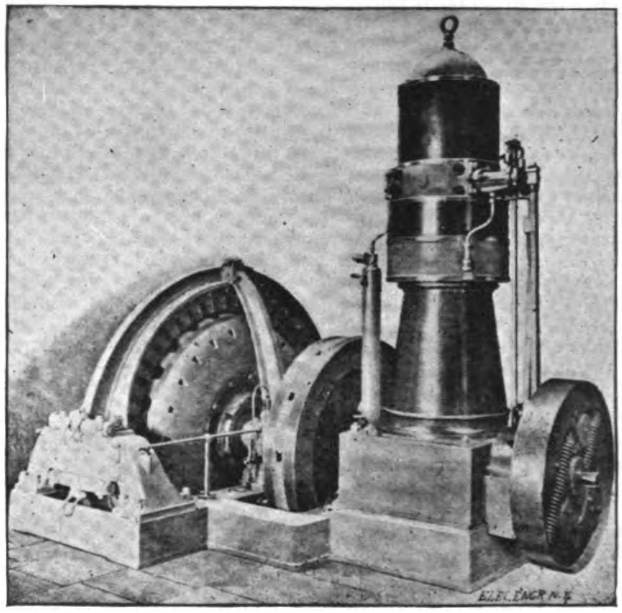


FIG. 1.—THE RAWORTH UNIVERSAL ENGINE DIRECTLY CONNECTED TO MORDEY ALTERNATOR.

The low pressure cylinder steam on the downward stroke of the piston expands until the cut-off closes, when the remainder passes into the receiver, except a small amount which is retained in the cylinder for the purpose of compression. If any water is taken into the high pressure cylinder it is discharged into the low pressure, and through holes in the latter into the lower exhaust chamber when the low pressure piston reaches the bottom of its stroke.

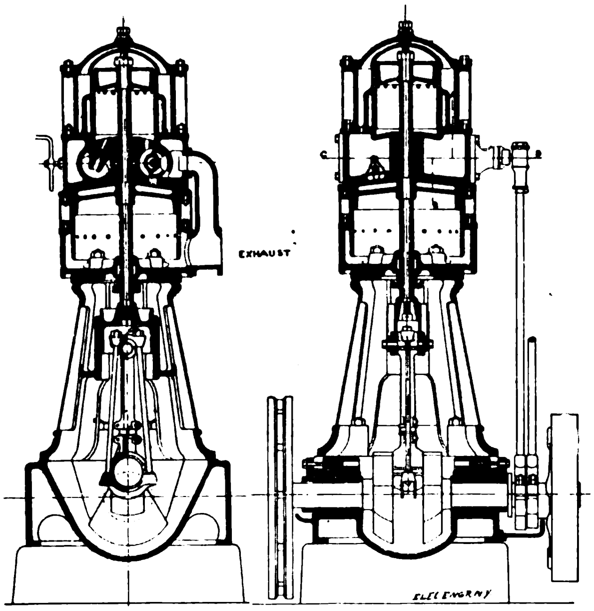
The triple and quadruple expansion engines are arranged with two cranks and two pairs of cylinders. With the former class the high pressure and intermediate cylinders are in tandem over one crank, and two low pressure cylinders are placed in tandem over the other crank.

The cross sections shown in Figs. 2 and 3 are taken at right angles and parallel to the engine shaft. These illustrations apply to the compound engine with one crank and only incidentally to the triple and quadruple patterns. The general arrangement of the parts of the engine will be understood by reference to these sections.

The high pressure eccentric is driven by a centrifugal shaft governor, which controls the cut-off from zero to ⅝ stroke, and

the low pressure eccentric is fixed solidly on the shaft so as to cut off at about ½ stroke. The lubrication is entirely automatic.

The connecting rod is made in two separate parts, one of



FIGS. 2 AND 3.—THE RAWORTH UNIVERSAL HIGH SPEED ENGINE.

which is an external frame to take the pull on the up stroke, and the other an internal strut to take the pressure of the down stroke. The governor in principle is similar to the ordinary crank shaft automatic governor, and is very simple in construction. The springs are fitted with an adjustment with

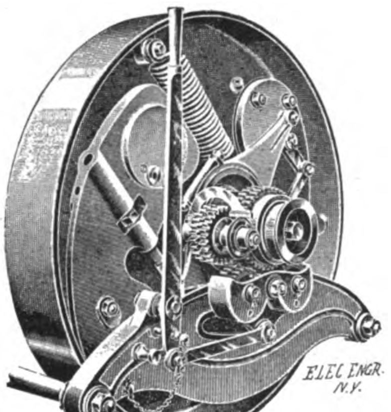


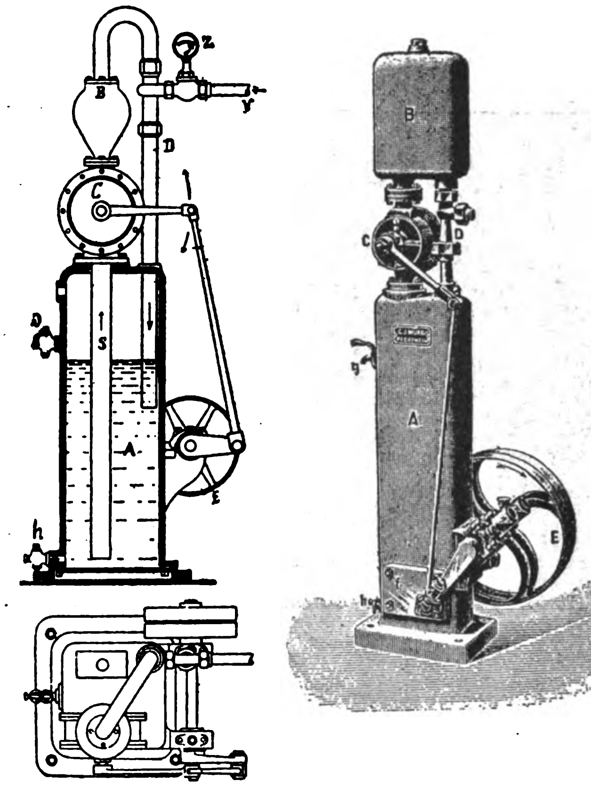
FIG. 4.—THE UNIVERSAL ENGINE GOVERNOR.

which the range of total variation in speed can be set at from one to five per cent. When the speed may be required to vary while working, the Raworth speeder gear, shown in Fig. 4, is used. This is required when the engine is used for driving alternators in parallel.

THE MURRH VACUUM PUMP.

INCANDESCENT lamp manufacturers and those engaged in vacuum tube work on a large scale, may be interested in a novel vacuum pump devised by Mr. J. Murrh, of Pforzheim, and described in "Dingler's Polytechnisches Journal." This pump is characterized by the absence of all pistons, valves and other delicate appliances usually found in ordinary air pumps. The apparatus, which is very simple, is represented in section in Fig. 1, and in elevation, with some slight modifications, in Fig. 2. It is based on the principle of the ejector and consists of a cylinder, A, three-quarters filled with water, which a rotary pump, C, draws up through the pipe, s, filling the air reservoir, B. From here the water flows out very rapidly by the pipe, D, drawing the air through the tube, v, which communicates with the vessel to be exhausted.

The mixture of water and air is returned to the cylinder, A, while the air escapes through the cock, G, the water coming



THE MURRH VACUUM PUMP.

back to the original circulation. The following table gives the dimensions and capacities of three sizes of these machines:

Floor space occupied....	0.2 sq. m.	0.3 sq. m.	0.4 sq. m.
Height	1.6 m.	1.7 m.	1.8 m.
Number rev. per minute	80	60	40
Vol. air withdra'n per hr.	4 cu. m.	8 cu. m.	12 cu. m.

The pressure of air necessary in the reservoir will not exceed 1½ atmospheres. A manometer, Z, at every instant indicates the degree of vacuum obtained in the vessel operated upon.

SOCIETY AND CLUB NOTES.

INTERNATIONAL CONGRESS OF ELECTRICAL ENGINEERS AT GENEVA.

On the occasion of the Swiss National Exhibition at Geneva, the Society of Swiss Electrical Engineers has resolved to hold, during the month of August, an International Congress of Electrical Engineers, and has now sent invitations to different foreign societies. The Congress will last four days and the following subjects have been included in the programme: (1) Magnetic units and their nomenclature; (2) Photometric units and their nomenclature; (3) Long-distance transmission of energy and its distribution by continuous and alternating currents; (4) Protection of high-pressure circuits from atmospheric discharges; (5) Disturbances caused by electric tramways. In connection with the Congress there will be excursions into the Jura and central districts of Switzerland for the purpose of inspecting various important electrical plants.

AN ELECTRIC CLUB AT WASHINGTON, D. C.

The Washington Electric Club has been organized by the election of the following officers: President, M. O. Spring; vice-president, J. K. Vose; secretary and treasurer, Arthur E. Yundt; librarian, H. P. Moore; directors, Fred Royce, Jr., Fred McIntyre, Robert D. Metzel, William Watzel, A. V. Holmes; sergeant-at-arms, William E. Dykes.

EXHIBITION NOTES—V.

THE NOWOTNY ARC LAMP EXHIBIT.

ONE of the exhibits which attracted the attention of visitors at the Electrical Exposition was that of the Nowotny Electric Company, of Cincinnati, a general view of whose

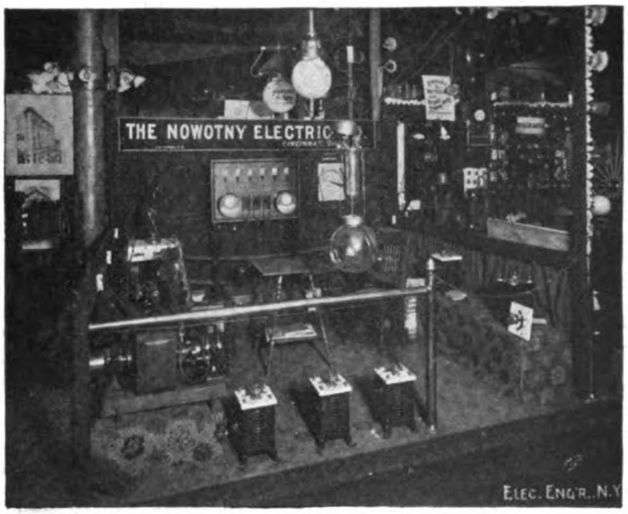
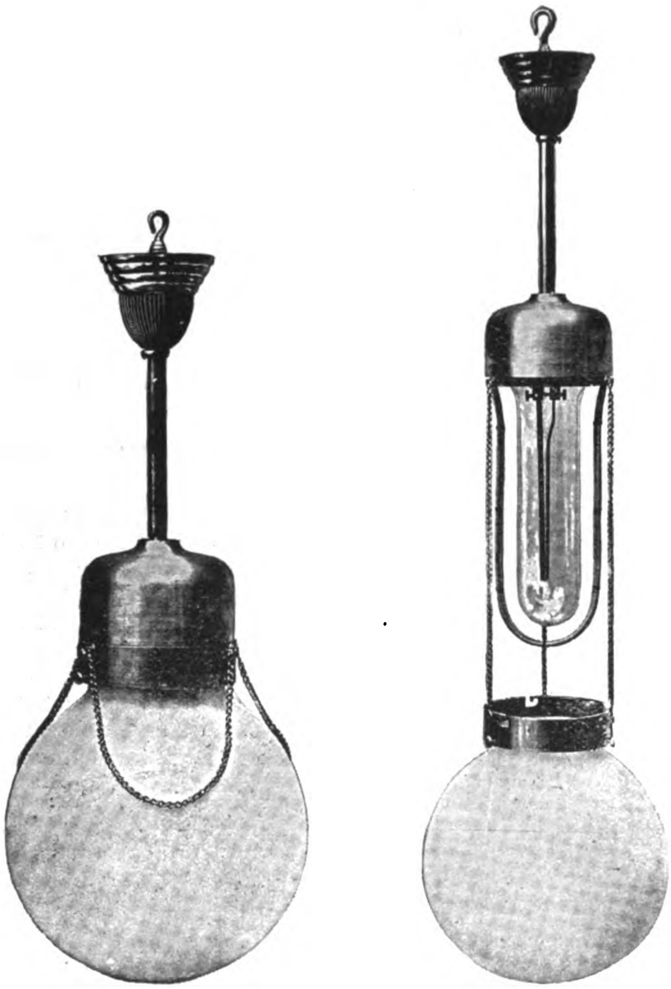


FIG. 1.—THE NOWOTNY ELECTRIC CO.'S EXHIBIT.

booth is shown in Fig. 1. The arc lamp which this company manufactures is shown complete in Fig. 2 in the style made



FIGS. 2 AND 3.—THE NOWOTNY ARC LAMP.

for indoor use. Figs. 3 and 4 show respectively the method of suspending the globe, and the working parts of the lamp. The carbons are placed parallel to each other throughout the entire length to be consumed by the arc, and are flat in shape, the broad sides facing each other. The arc is kept at the points of the carbons by means of a magnetic field which is generated in a coil lying in a plane parallel to the axes of both carbons, as shown in Fig. 4. The entire mechanism and the carbons are inclosed in a single glass globe which protects them from any access of fresh air, thus considerably prolonging the life of the carbons.

The only moving part in the lamp is one carbon holder, which is pivoted at the top, and allows sufficient movement, so that

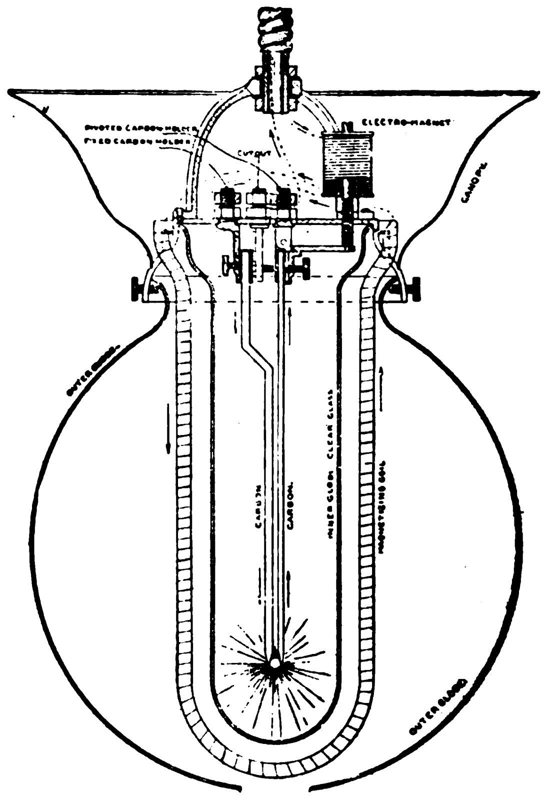


FIG. 4.—THE NOWOTNY ARC LAMP.

the points may be brought into contact at their tips and to separate sufficiently to maintain the required arc. This movement is obtained by means of a single solenoid magnet, which draws up an arm fastened to the pivoted carbon holder.

The lamp is manufactured for arc, constant potential continuous and alternating circuits. It is of a short length and occupies but little room; it is also easily trimmed and is made up in ornamental designs. An automatic cut-out is provided and an inspection of the working parts shows an entire absence of rods, sliding contacts, chimney, clockwork and springs.

THE WESTERN UNION'S RECORD IN SENDING THE DEPEW-ADAMS MESSAGES.

WE are indebted to Mr. C. A. Tinker, of the Western Union Telegraph Company, for the accompanying data in regard to the work done on the night of May 16, in sending the Depew and Adams messages around South America and across to Europe and back.

Preparatory to transmission, the circuit was made up from the exposition building to the following points, at which automatic repeaters were introduced, viz., Pittsburg, Pa.; Chicago, Ill.; Omaha, Neb.; Cheyenne, Wyo.; Ogden, Utah; Reno, Nev.; San Francisco, Cal.; Los Angeles, Cal.; Flagstaff, Ariz.; Pueblo, Colo.; Kansas City, Mo.; Chicago, Ill.; St. Louis, Mo.; Little Rock, Ark., to Galveston, Texas, a distance of 7,397 miles of wire, fourteen sets of repeaters. At the exposition building, the gold key used by President Cleveland in opening the World's Fair at Chicago in 1893 was placed in circuit.

The messages were received for dispatch by Mr. C. A. Tinker at the exposition and instantly put upon the wire in direct communication with Galveston, where they were received by Colonel L. C. Baker, superintendent, the transmission occupying six minutes, by the official time-keeper's (Mr. Abbott) record. From Galveston they were transmitted to Buenos Ayres,

via Mexican Telegraph Company and Central South American Telegraph Company (including land lines across the continent of South America, and over the Andes from Valparaiso to Buenos Ayres), 6,272 miles; via River Plate Telegraph Company, Buenos Ayres to Montevideo, 114 miles; via Western and Brazilian Telegraph lines, Montevideo to Pernambuco, 2,364 miles; via Brazilian submarine cables, Pernambuco to Lisbon, 3,663 miles; via Eastern Telegraph Company, Lisbon to Penzance, 899 miles; via Western Union Telegraph Company's Atlantic cables, Penzance to Canso, 2,620 miles. On their return the messages were received over the cable wire from Canso, N. S., 1,187 miles (repeaters at St. John, N. B., and Bangor, Me.), and copied upon a typewriter by Operator George W. Dickson, and delivered to Mr. Depew. The two messages contained sixty-eight words, and were transmitted from the exposition building, New York, over a total distance by land lines and cables, of 24,516 miles, and received back at the exposition building in twenty-one and one-half minutes.

NILES TOOL WORKS CO.'S EXHIBIT.

The Niles Tool Works Co., of Hamilton, O., had a prominent place on the main floor and were the only machine tool builders to make an exhibition of machine tools driven by electric motors. The No. 1½ radial drilling machine attracted much attention, as it was driven direct by a three horse-power Card motor, no belts being used, and also on account of the universal manner and ease with which it could be operated.

Another machine of no less importance from a mechanical standpoint was the thirty-seven-inch boring and turning mill.

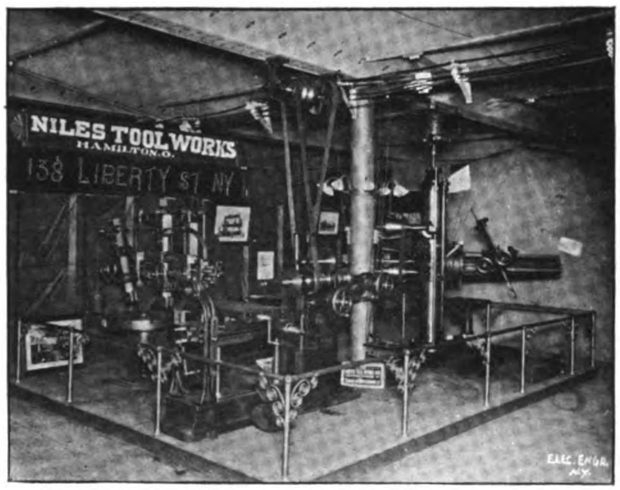


EXHIBIT OF THE NILES TOOL WORKS.

This machine was driven direct by a three horse-power Card motor, which occupied the place on the driving shaft usually taken by the cone pulley when the machine is driven by belt. The rheostat or controller of this machine has seven changes and of course the back gear doubles this or makes fourteen changes in all.

The other machine on exhibition was their No. 1 horizontal boring and drilling machine. This machine was belted from a countershaft and the countershaft was driven by a 2½ horse-power Card motor, bolted to the floor. All the above machines were run at the same speeds generally used in modern machine shop practice, and when in motion one could see how smooth was the working of the parts.

Card motors, built by the Card Electric Motor and Dynamo Company, of Cincinnati, O., were used by the Niles Company in their installation. Mr. Becker, the representative of the Niles Company, informs us that the Card motors have given excellent satisfaction wherever placed by his company on their machinery.

The Niles Tool Works were among the first to adopt electric motors direct on machine tools, and the success of their venture proves that direct driven machine tools is what the machine tool users want.

Mr. Becker has shipped the entire above exhibit to Boston, Mass., where the Niles Company intend to place it in their store and have the exhibition of these tools permanent. The Niles Company report some sales and many inquiries during the show, and are well pleased with the success of the exhibition generally.

A. K. WARREN & CO.'S EXHIBIT.

THE accompanying illustration shows the booth of A. K. Warren & Co., at the Electrical Exposition. Their exhibit was an eminently practical one, as the work of rewinding and repairing electrical machinery was actually carried on by workmen. The exhibit also included special tools which may

A. K. WARREN & CO.'S EXHIBIT.

be adjusted to any dynamo for the purpose of turning off commutators without the removal of the armatures. Besides these there were also shown various styles of brushes and brush holders, and numerous other parts which are called for in the repairing and maintenance of electrical machinery which is carried on by this company.

THE BRADFORD BELTING CO.'S EXHIBIT.

WE illustrate herewith the exhibit of the Bradford Belting Company, of Cincinnati, O., which contained a complete line of Monarch belting and Monarch paints. The Monarch paint proved a noticeable attraction, as samples of wood and

THE BRADFORD BELTING CO.'S EXHIBIT.

iron covered with it were freely exposed to the action of a torch without producing any deleterious effects.

This insulating paint is largely used for insulating armatures, fields and other electrical apparatus, and the tests to which it was subjected during the exposition left a favorable impression of its merits upon all who witnessed them.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S ELECTRICAL PATENTS ISSUED MAY 26, 1896.

Conductors, Conduits, and Insulators:—

CABLE GRIP. P. Wunderle, Providence, R. I., 560,828. Filed March 24, 1896.
The weight of the cable keeps clip in place.

Distribution:—

ELECTRICAL DISTRIBUTING SYSTEM. R. R. Bowker, Brooklyn, N. Y., 560,772. Filed Feb. 27, 1896.
For description see page 620, this issue.

SYSTEM OF ELECTRIC DISTRIBUTION. P. O. Keilholtz, Baltimore, Md., 561,002. Filed Feb. 29, 1896.
Consists in reducing its field strength and load in accordance with the current applied to the armature.

Dynamos and Motors:—

ELECTROMAGNETIC MOTOR. F. M. Schmidt, Brooklyn, N. Y., 560,652. Filed Jan. 18, 1896.

ALTERNATING CURRENT GENERATOR. W. S. Moody, Lynn, Mass., 560,735. Filed Jan. 17, 1896.
Method of compounding alternating dynamo electric machines for change of potential under change of load.

COMMUTATOR BRUSH. W. H. Morgan, Alliance, O., 560,737. Filed Feb. 20, 1895.
Composed of a series of independently yielding sections having curved non-coincident contact edges.

Electro-Metallurgy:—

ELECTROLYTICAL APPARATUS. W. S. Rawson, London, England, 560,931. Filed March 21, 1895.
Apparatus for effecting electrolytical deposit of metal upon such articles as can be rolled over and over in a revolving barrel, so arranged that these articles constitute the cathodes as they roll on the periphery of the barrel.

Lamps and Appurtenances:—

INCANDESCENT LAMP SOCKET. H. C. Wirt, Schenectady, N. Y., 560,667. Filed Feb. 17, 1896.
The base is formed of molded insulating material.

ELECTRIC ARC LAMP. T. E. Adams, Cleveland, O., 560,671. Filed Jan. 4, 1896.
Comprises an inner arm inclosing globe having its bottom completely and permanently closed and its top normally closed.

ELECTRIC ARC LAMP. J. H. J. Haines, New York, and A. B. Fernald, Jersey City, N. J., 560,792. Filed Jan. 7, 1896.
Embodies a "ball-clutch" feed mechanism.

COMBINED GAS AND ELECTRIC LIGHT FIXTURE. L. Stieringer, New York, 11,544. Filed March 4, 1894. Reissued.
See page 607, E. E., June 3.

Miscellaneous:—

APPARATUS FOR PRODUCING MUSICAL SOUNDS BY ELECTRICITY. G. Breed, Philadelphia, Pa., 560,679. Filed Nov. 20, 1894.
A series of musical strings, in combination with a series of electromagnets arranged in parallel and connected with a source of electric energy, and a system of two-way switches controlling the current to the electromagnets.

FEED-WATER PURIFIER. M. S. Cabell, Quincy, Ill., 560,685. Filed Dec. 26, 1894.
Electropositive and electronegative plates having perforations for the passage of the feed-water and means for spraying the water upon the same.

ELECTRIC VALVE. C. L. Fortier, Chicago, Ill., 560,703. Filed Oct. 10, 1892.
Means for preventing sticking of the armature to the cores of the magnet.

AUTOMATIC HEAT REGULATING DEVICE. J. V. Stout, Easton, Pa., 560,763. Filed June 6, 1895.
Details of construction.

STATIC ELECTRICAL MACHINE. C. M. Hollopeter, Fostoria, O., 560,852. Filed July 10, 1895.
A rectangular frame, consisting of opposite insulated pairs of frame conductor rods, the stationary and revolving generator plates mounted within the frame, and swinging adjustable prime conductors pivotally connected, respectively, with the opposite pairs of frame rods.

THERMOMETRIC CIRCUIT CLOSER OR ALARM. R. Pearson, London, England, 560,921. Filed Sept. 3, 1895.
A mercury column makes contact between platinum contacts.

LIGHTNING ARRESTER. W. Cooper, Schenectady, N. Y., 561,073. Filed Sept. 23, 1895.
An air-tight box having terminals with a gap between them, and a weak cover that is adapted to be blown away.

ELECTRO-THERAPEUTIC APPARATUS FOR TREATING DEAFNESS. S. J. Collier, Chicago, Ill., 561,046. Filed Oct. 22, 1895.
Designed to supply a mechanical massage to the ear drum, muscles and small bones of the ear, and at the same time to stimulate the nerves and muscles with a secondary current of electricity.

Railways and Appliances:—

CONTROLLER FOR ELECTRIC CARS. E. A. Sperry, Cleveland, O., 560,658. Filed March 20, 1896.
A single reversing switch for reversing the direction in which the car shall travel and also for reversing the relation between the armature and field coils when the brake is to be used.

ELECTRIC BRAKE. W. B. Potter, Schenectady, N. Y., 560,751. Filed March 13, 1896.
The combination of a controlling switch, a reversing switch, and a braking switch provided with two sets of contacts corresponding to the forward and backward running positions of the reversing switch, and an interlock between the reversing switch controller and braking switch; the interlock arranged to permit the operation of the braking switch in one direction when the reversing switch is set forward, and in the other direction when the reversing switch is set back.

ELECTRIC RAILWAY. H. Brandenburg, Chicago, Ill., 560,678. Filed March 11, 1895.
A slotted tubular conductor, a trolley having a beaded plate and a sleeve carrying a multiplicity of contacts mounted on said bead.

ELECTRIC RAILWAY. E. H. Johnson, New York, and R. Lundell, Brooklyn, N. Y., 560,721. Filed Oct. 15, 1895.
Consists in conveying the leaking currents around the switching mechanism and thereby causing said switching mechanism to assume normal position.

CONDUIT ELECTRIC RAILWAY. W. Lobach, Chicago, Ill., 560,807. Filed April 23, 1894.
A conduit containing a liquid insulator heavier than water, in which the conductor is laid.

CURRENT COLLECTOR FOR ELECTRIC RAILWAYS. A. N. Connett, Washington, D. C., 560,841. Filed Jan. 17, 1896.
A traveling contact comprising a hanger, oppositely disposed contact shoes, an interposed toggle, and a spring connection between the toggle and hanger.

CURRENT COLLECTOR FOR ELECTRIC RAILWAYS. A. N. Connett, Washington, D. C., and J. S. Detrick, Baltimore, Md., 560,894. Filed Jan. 17, 1896.
Similar to above.

ELECTRIC RAILWAY. W. H. Jordan, Brooklyn, N. Y., 560,903. Filed Jan. 17, 1896.
System of signaling.

ELEVATED ELECTRIC RAILWAY. J. H. McGurty, Jersey City, N. J., 560,917. Filed June 13, 1895.
Comprises a switch upon the car and trips at proper intervals for engaging with the switch to make and break the circuit automatically.

ELECTRIO RAILWAY SYSTEM. N. J. Halpine, United States Navy, 560,988. Filed Feb. 1, 1893.
A sectional conduit system in which the sections are shorter than the car; the conductor being protected by the car while the car is receiving current.

ELECTRIC LOCOMOTIVE. J. C. Henry, Denver, Colo., 11,542. Filed Nov. 21, 1893. Reissued.
In combination with the wheels and axles of a car truck, a frame supported on said axles, a motor supported rigidly on said frame by its fields and having a bearing adapted to receive the weight of the car body.

ELECTRIC LOCOMOTIVE. J. C. Henry, Denver, Colo., 11,543. Filed Nov. 21, 1893. Reissued.
Speed reducing gear connecting the armature shaft of motor with the axles and comprising an internal gear which has bearing on one of the bars of the truck frame.

Switches, Cut-Outs, Etc.:—

CONTROLLABLE SWITCH BOX. J. Van Vleck, New York, 560,766. Filed Jan. 3, 1896.
For description see page 620, this issue.

AUTOMATIC FUSE. H. C. Reagan, Jr., Philadelphia, Pa., 560,819. Filed Sept. 6, 1895.
One fuse is put in circuit after the other.

ELECTRIC CUT-OUT. J. C. Reynolds, New York, 560,821. Filed Jan. 25, 1896.
The wires are coupled to studs of insulating material and are pressed into contact by a cap of inclosing cover, also of insulating material.

AUTOMATIC DEVICE FOR REMOVING RESISTANCE IN STARTING ELECTRIC MOTORS, ETC. G. H. Whittingham, Baltimore, Md., 11,545. Filed April 24, 1894. Reissued.
A pawl and ratchet operated by the motor armature and adapted to impart to the contact device a limited movement in the direction which reduces the resistance of the armature circuit.

Telephones:—

BUSY SIGNAL FOR TELEPHONE LINES. C. E. Scribner, Chicago, Ill., 560,757. Filed Aug. 17, 1895.
A switch lever of a telephone set, an indicator adapted to be set by the movement of the lever, a detent controlling the movement of the indicator, and an electromagnet acting upon the detent.

TELEPHONE CIRCUIT. J. S. Stone, Boston, Mass., 560,761. Filed March 13, 1896.
The combination, with a telephone circuit, of a generator and a relay in a permanent bridge between the circuit conductors, the generator being interposed between the coils of the relay, and a local circuit, including a battery, a line lamp signal controlled by the relay, and means for shunting the signal when connection is made with the line.

TELEPHONE CIRCUIT AND APPARATUS. J. S. Stone, Boston, Mass., 560,762. Filed April 2, 1896.
A telephone system of two telephone circuits, an electromagnetic device interposed in the circuit and placed in such relation to the transmitter and receiver and to the terminals of the other circuit as to constitute a repeating induction coil between the instruments.

TELEPHONE EXCHANGE SYSTEM. W. W. Dean, St. Louis, Mo., 560,845. Filed April 3, 1896.
Means for closing the battery circuit over the two limbs of each of the telephone lines.

MULTIPLE TELEPHONY. F. A. Pickernell, Newark, N. J., and F. S. Perrin, New York, 560,861. Filed March 21, 1896.
Has for its object the establishment of a practical working balance in superimposed circuits.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS ISSUED JUNE 2, 1896.

Alarms and Signals:—

SIGNAL BOX. J. J. Ruddick, Newton, Mass., 561,525. Filed Sept. 20, 1895.
Consists of an escape-wheel, signal-pins on its side, arranged in groups and forming lateral extensions of the teeth, and a circuit-breaker, the movable member of which is operated by the signal-pins.

SIGNAL BOX. J. J. Ruddick, Newton, Mass., 561,526. Filed Oct. 9, 1895.
Governing devices for the escape-wheel which are constructed to retard its action.

Primary Batteries:—

COMPOSITION FOR EXCITING FLUIDS FOR ELECTRICAL BATTERIES. F. G. Curtis, Philadelphia, Pa., 561,204. Filed Feb. 13 1893.
Consists of a solution of sulphate of aluminum, acetate of lead, hyposulphite of soda and sulphuric acid.

POLE PIECE FOR ELECTRICAL BATTERIES. F. G. Curtis, Philadelphia, Pa., 561,205. Filed Feb. 20, 1893.
A carbon plate having electrically deposited thereon an alloy of copper and tin.

Conductors, Conduits, and Insulators:—

WIRE CONNECTOR. A. Gartner, Newark, N. J., 561,388. Filed April 17, 1896.
Consists of a metallic block provided with a central opening, and with two oppositely-arranged openings adapted to receive the wires to be jointed and their bent-over portions, respectively.

WIRE CONNECTOR. D. M. Robertson, Kearney, N. J., 561,438. Filed April 17, 1896.
Consists of two adjoining connecting-channels circular in cross-section.

Dynamos and Motors:—

ALTERNATING ELECTRIC MOTOR. J. A. G. Trudeau, Ottawa, Canada, 651,144. Filed July 18, 1894.
The armature coils and field coils are both connected to a source of electric supply, but in shunt relation to each other.

DYNAMO ELECTRIC MACHINE. A. I. Gravier, Paris, France, 561,390. Filed April 7, 1894.
Consists of an armature having a core, the windings on the same being arranged in sections which are mechanically and electrically independent of each other.

Lamps and Appurtenances:—

ELECTRIC LAMP HANGER. J. Schmidt, New York, 561,443. Filed Feb. 11, 1896.
A rotary spindle and means for rotating the same.

Measurement:—

ELECTRIC METER. A. G. Waterhouse, Hartford, Conn., 561,183. Filed May 27, 1895.
Consists of a time mechanism connected to a working circuit and adapted to run while a current is passing through the circuit.

Miscellaneous:—

TARGET APPARATUS. J. L. McCullough, Brooklyn, N. Y., 561,124. Filed March 13, 1896.
Means for showing whether aim is correct without the use of missiles.

ELECTRIC HEATER. H. A. Thomas, Niagara Falls, N. Y., 561,294. Filed Feb. 6, 1895.
Adapted for car use.

INDICATOR FOR THE SPEED OF REVOLUTION OF PROPELLERS. M. Pfatischer, Philadelphia, Pa., 561,430. Filed Aug. 12, 1895.
The current strength of a magneto-generator driven by the engine shaft indicates the speed.

TELLTALE FOR STEERING GEAR OF SHIPS. M. Pfatischer, Philadelphia, 561,431. Filed Aug. 12, 1895.
Mechanical connections between steering gear and a movable contact arranged to make a connection with a series of fixed contacts.

Railways and Appliances:—

TROLLEY SWITCH. M. Rangey and P. Plants, Schenectady, N. Y., 561,128. Filed Jan. 17, 1896.
Means for mounting it upon the wires without soldering.

TROLLEY STAND. F. N. Kelsey, New Haven, Conn., 561,168. Filed March 28, 1895.
Details of construction.

ELECTRIC RAILWAY. H. Brandenburg, Chicago, Ill., 561,307. Filed May 22, 1895.
Provides a conduit wherein the electric features may be auxiliary to a cable system.

MAGNETIC MEDICAL APPARATUS. A. B. Slater and N. A. Renstrom, Omaha, Neb., 561,448. Filed Oct. 9, 1894.
A support for a body, and electromagnets distributed beneath the surface of the support so as to create a magnetic field therein.

Switches, Cut-Outs etc:—

DOOR LOCK SWITCH FOR ELECTRIC LIGHTS. W. E. Goucher, Jamestown, N. Y., 561,107. Filed Jan. 2, 1896.
Locking the door breaks the circuit.

ELECTRIC SWITCH. F. Land, Syracuse, N. Y., 561,116. Filed June 19, 1895.
Adapted for use in an arc lamp.

FUSIBLE CUT-OUT. L. W. Downes, Providence, R. I., 561,159. Filed April 17, 1895.
A fuse-wire combined with a sheath of incombustible, insulating material, inclosing the fuse-wire and confining a body of air.

ELECTRIC SWITCH. H. Ross, Providence, R. I., 561,284. Filed Feb. 17, 1896.
Details of construction.

Telegraphs:—

AUTOMATIC TELEGRAPH. S. P. Freir, Hasbrouck, N. J., 561,547. Filed Aug. 9, 1893.
The combination of main-line transmitting apparatus by which the positive or negative pole of a battery or batteries may be directed to line, and variable-pressure main-line contact devices, whereby the touch of the fingers in the manual transmission of messages of such character may be reproduced.

Telephones:—

TELEPHONE EXCHANGE SYSTEM. K. B. Miller, Wilkinsburg, Pa., 561,335. Filed Feb. 18, 1896.
The subscribers' lines terminate in spring-jacks arranged in divided boards.

AUTOMATIC TELEPHONE CALL. G. Q. Dean and J. Dean, Jr., New York, 561,377. Filed Aug. 3, 1895.
A movable contact maker combined with a movable core, a vitalizer for the core, and a detent actuated by said core.

ATTACHMENT FOR TELEPHONES. J. H. Miller, Washington, D. C., 561,416. Filed March 12, 1896.
An attachment for preventing the turning of the bell-crank when telephone is in connection with another.

TELEPHONE SYSTEM. P. Minnis, Mobile, Ala., 561,417. Filed Feb. 17, 1896.
A series of subscribers' circuits connected to a return wire, a series of talking sets directly in the line-circuits and talking batteries in loop cords at the central station arranged so that the polarity of the several batteries in the return wire shall be the same.

TELEPHONE EXCHANGE SYSTEM. P. Minnis, Mobile, Ala., 561,418. Filed Feb. 17, 1896.
Similar to above.

SWITCHBOARD FOR TELEPHONE SYSTEMS. P. Minnis, Mobile, Ala., 561,419. Filed Feb. 17, 1896.
Relates to visual call-signals.

LINE-JACK FOR TELEPHONIC SWITCHBOARDS. P. Minnis, Mobile, Ala., 561,420. Filed Feb. 17, 1896.
So constructed that two separate wires entering it may be connected by a slight movement of the operator's finger.

TELEPHONE CALL BOX. P. Minnis, Mobile, Ala., 561,421. Filed Feb. 17, 1896.
Details of construction.

TELEPHONE CALL SIGNAL FOR CENTRAL STATIONS. P. Minnis, Mobile, Ala., 561,422. Filed Feb. 17, 1896.
Employs small incandescent lamps.

TELEPHONE. P. Minnis, Mobile, Ala., 561,423. Filed Feb. 17, 1896.
Arrangement whereby the receiver and transmitter may be mounted upon a single handle.

TELEPHONE SWITCH PLUG. P. Minnis, Mobile, Ala., 561,424. Filed Feb. 17, 1896.
A plug having a cap, whereby two wires may be connected by pushing said cap.

PARTY-LINE TELEPHONE APPARATUS. W. W. Dean, St. Louis, Mo., 561,498. Filed March 28, 1896.
Means for communication between several subscribers without calling the central station.

LEGAL NOTES.

NIAGARA WATER POWER UTILIZATION.

On Thursday, May 28, just before the close of the thirty-day period following the end of the Legislature's session, Governor Morton signed the bill confirming and ratifying the power rights of the Niagara Falls Hydraulic Power and Canal Company, of which W. C. Johnson, Amer. Soc. Civ. Eng. is chief engineer. This company is the oldest power concern at the Falls, and now for the first time it has a legal and recognized right to divert water from the Niagara River for power purposes, the bill containing the following important declaration:

"Section 1. The right of the Niagara Falls Hydraulic Power and Manufacturing Company to take, draw, use, and lease and sell to others to use the waters of Niagara River for domestic, municipal, manufacturing, fire, and sanitary purposes and to develop power therefrom for its own use and to lease and sell to others to use for manufacturing, heating, lighting, and other business purposes, is hereby recognized, declared, and confirmed, and the exercise thereof by said company, its successors, and assigns, to take and to draw water from Niagara River for use and disposal to others to use for the purpose above specified, and for the development of power for use and for disposal to others to use, for purposes above mentioned, is hereby limited and restricted to such quantity of water as may be drawn by means of the hydraulic canal of said company when enlarged throughout its entire length to a width of 100 feet and to adopt a slope sufficient to carry at all times a maximum uniform depth of fourteen feet of water, provided that exercise by said company of the rights hereby declared and confirmed shall not impair the practical navigation of Niagara River.

NEWS AND NOTES.

LORD KELVIN'S JUBILEE.

The following is to be the programme of the jubilee celebrations of Lord Kelvin's professoriate at Glasgow. On the evening of Monday, Jun 15, at 8:30 o'clock, the University will give a conversazione, when there will be an exhibit of Lord Kelvin's inventions. On Tuesday, June 16, addresses will be presented to Lord Kelvin by delegates from home and foreign University bodies, from several of the learned societies of which he is a member, from student delegates from other universities, and from the students and graduates of the University of Glasgow. It is expected that the honorary degree of LL. D. will be conferred on the same day on several of the distinguished foreign visitors. On Tuesday evening, June 16, the city will give a banquet to Lord Kelvin, to which the visitors who have come to do him honor have been invited. On Wednesday, June 17, the senate of the University will invite the visitors of the University staff to sail down the Clyde. The students of the University also invite the student delegates from other universities to a similar trip. Representative scientific men—about fifty in number—from America and the British colonies, and from all the European countries, and about 150 from the United Kingdom have signified their intention to be present.

THE "ELECTRICAL ENGINEER'S" COLUMBIAN EXPOSITION AWARD.

The Electrical Engineer has just received a diploma and bronze medal for the 1837 model of Davenport's electric railway exhibited by it at Chicago in 1893.

Trade Notes and Novelties

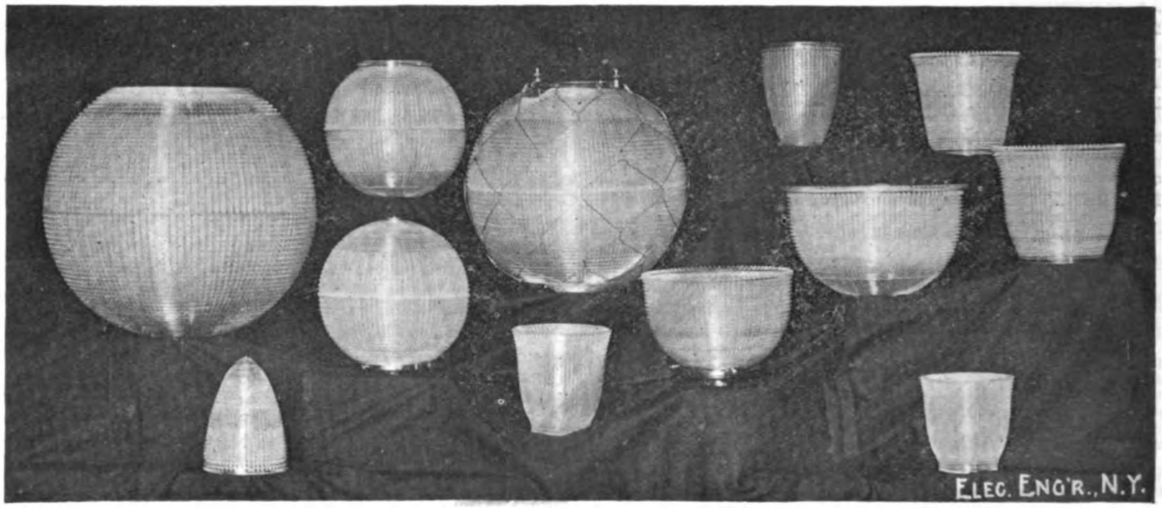
AND MECHANICAL DEPARTMENT.

HOLOPHANES.

THE name "holophanes" has been adopted by the George A. Macbeth Company, of Pittsburg, Pa., for a new line of shades which they are manufacturing and which have some special features that will be seen in the accompanying illustration.

These holophanes are made of plain glass, the inner surface of which is pressed into horizontal groovings of well defined curvature, and the exterior is formed under heavy pressure into prisms or rings, constructed so as to both reflect and refract the light. By this means the source of light is not visible, but is diffused evenly from the entire surface of the shade.

This even, luminous surface is not produced by any opaqueness or roughness of the glass which would absorb considerable of the light emitted by the lamp, but is due entirely to the arrangement of the reflecting and refracting surfaces and prisms of the shades. There is an entire absence of alternate light and dark streaks upon the shades, and no shadow is produced directly underneath them. The holophanes are manufactured in various shapes and sizes, so as to direct the light either horizontally or downward, or both, as may be required, and are made for use with both arc and incandescent lamps.



HOLOPHANE GLOBES FOR ARC AND INCANDESCENT LAMPS.

NIAGARA FALLS POWER CO.

The annual meeting of the Niagara Falls Power Company was held June 1, and the old directors and officers were reelected. The principal officers are: President, Dr. Coleman Sellers, of New York; vice-president, Benjamin Flagler, of Niagara Falls; second vice-president, Charles Sweet, of Buffalo.

Contracts were executed with the Westinghouse Electric Company for seven more 5,000 horse-power dynamos and the E. D. Smith Company, of Chicago, for the wheel pit and power house extension. The work will involve about $3,000,000. The extension is to furnish power for Buffalo, beginning June, 1897, under the terms of the contract with the city, already published in our columns.

CARBORUNDUM.

THE Carborundum Company, of Niagara Falls, N. Y., have just published a very complete catalogue describing their product which has been found to be next to the diamond in the scale of hardness. Carborundum is the invention of Mr. E. G. Acheson, president of the Carborundum Company, who for a long time was occupied with experiments to produce an abrasive substance for industrial purposes which would excel emery and corundum in hardness. As the diamond, which is a carbon crystal, is the hardest substance known, the idea was conceived of heating carbon and clay together, so that when the latter was fused the carbon would dissolve in the silicate of alumina of the clay, and on cooling carbon crystals would be formed.

A company was formed in Monongahela, Pa., in 1891, to carry out this operation experimentally, and the success which was achieved in producing a very hard abrasive led to the foundation of a plant at Niagara Falls, where the current necessary for the manufacture of carborundum was available to any amount.

About 1,000 horse-power in current is used by this company in the manufacture of carborundum, and their present output is about two tons per day.

Among the properties of this substance may be mentioned its infusibility and insolubility. It separates into carbon and silicon when raised above the temperature at which it is manufactured, but with no signs of fusion, and even hydrofluoric acid has no effect upon it. Its specific gravity is 3.23, and its prevailing colors are green, blue and black.

Carborundum is sold for industrial purposes in the shape of crystals and powders of various degrees of fineness, and also in numerous forms of grinding tools, as well as on cloth. For grinding and polishing purposes it has been found of unusual value, and its merits are also attested by awards of medals from the Franklin Institute and the Columbian Exposition.

BALL ELECTRIC LIGHTING PLANT.

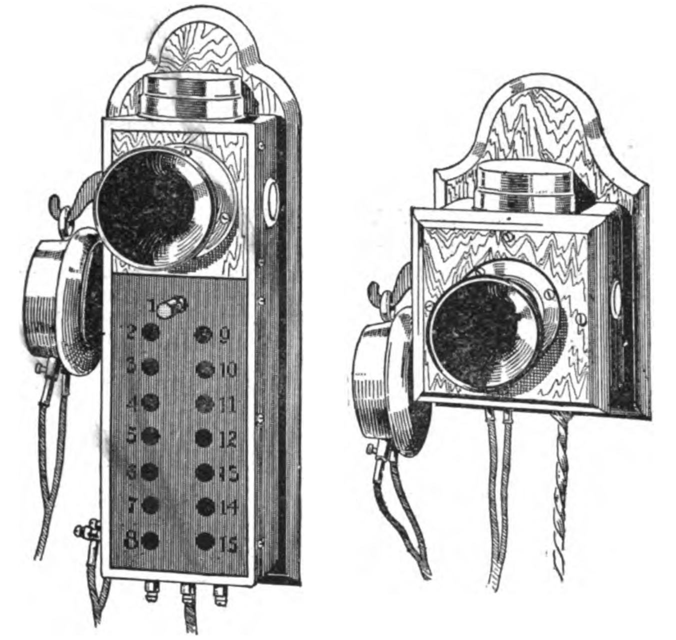
The Ball Electric Light Company, who had a very neat exhibit at the Electrical Exposition, are able also to give out a good list of recent sales, backed up by some very handsome testimonials. The apparatus on view at the show has already been disposed of. The company's recent sales are: West Warren Cotton Manufacturing Company, Warren, Mass, 200 lights; Androscoggin (Me.) Mills, 100 lights; Dunn Worsted Mills, Woonsocket, R. I., 100 lights; Berkshire Cotton Manufacturing Company, Adams, Mass., 250 lights; Lake City (Fla.) Water and Light Company, 100 lights; Heather & Co., New York City, 20 lights; Hilton, Dodge Lumber Company, 16 lights; Ellenville, N. Y., 70 lights, making a total of 786 arcs lately sold.

L. A. CHASE & CO.

L. A. CHASE & COMPANY (Incorporated), of 161 Forthill square, Boston, Mass., have issued a catalogue displaying a somewhat novel feature. They convey to the public a convincing idea of the extensive facilities with which their electrical manufacturing and repair factory is provided, not so much by verbal description as by a series of excellent photographic reproductions of the equipment of their several departments. Besides the shops devoted to dynamo and motor work, armature winding, etc., the testing department is fully illustrated. Its equipment is thoroughly up to date, including the most modern instruments for testing in all classes of electrical work, such as wattmeter tests, voltmeter calibration, high and low resistance measurements, lamp testing, and various other essential tests, so often out of reach of electrical stations.

THE SIMPLEX INTERIOR TELEPHONES.

The Simplex Interior Telephone Company, 611 Johnstone Building, Cincinnati, are making a line of residence and intercommunicating instruments, two of which we illustrate below. Fig. 1 shows an instrument for intercommunication between various points within large stores, office buildings, factories, etc., wherever quick local communication is required. In this system any one station may connect direct with any other station and no central station is required. These instruments are of small size and they have a maximum capacity of thirty stations. Fig. 2 shows an hotel instrument



FIGS. 1 AND 2.—THE SIMPLEX INTERIOR TELEPHONES.

of novel design, which does not require a battery at each instrument. It can be readily attached to existing push button wires, and in connection with a switching device for annunciators makes a complete system for communication from different points to one central point, as from the various rooms of a hotel to the office. If desired this instrument may be applied to a part of the rooms only, without interfering with the present service of the rest. The company are doing a nice business in these telephones, which are giving general satisfaction.

AMERICAN GOODS FOR ENGLAND.

Mr. F. T. Eggers, managing director of the Electrical Company, Limited, of London, has been in this country arranging for the opening of an American department for the sale of electrical apparatus and supplies in London.

The Electrical Company, Limited, have an extensive office and warehouse at 122 and 124 Charing Cross Road, London, and are a branch of the great Allgemeine Elektricitäts Gesellschaft, of Berlin. To keep in touch with American manufacturers, Mr. Eggers has arranged with the Chapin-Douglas Electric Company, 136 Liberty street, New York, to do the buying, and to this firm should be addressed price lists and proposals for the exclusive sale in the United Kingdom of apparatus and specialties. Attention will also be given to new inventions either for the financing of patents for England or the control in selling the goods themselves.

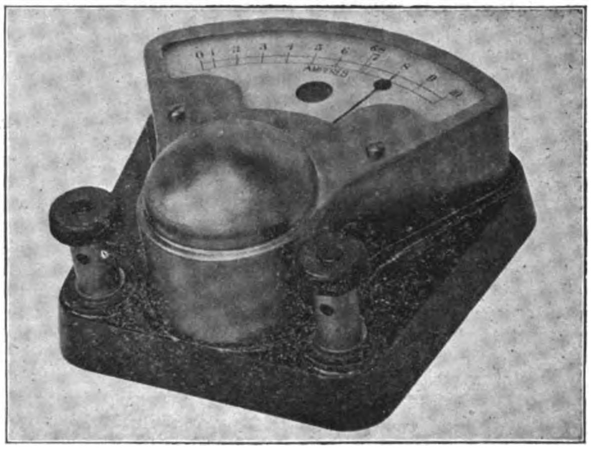
TRANSLUCENT FABRIC CO.

The special fabric made by the Translucent Fabric Company, Quincy, Mass., is now taking an important place as a substitute for glass in mills, foundries, gunpowder mills, machine shops, train sheds, and all places where the breakage of glass constitutes an element of danger, annoyance and expense. The introduction of iron and steel in the construction of buildings has given quite an impetus to the demand for the new material, which consists of wire cloth, 12 meshes to the inch, covered and filled in with a semi-transparent, impervious substance. This fabric transmits a large amount of light, and is strong, flexible, weatherproof, durable, and practically unbreakable. It has the further important advantage of being virtually fireproof. Its cost is about the same as that of heavy skylight glass.

THOMSON ARC CIRCUIT AMMETER.

The standard instruments which the General Electric Company have lately placed upon the market include the Thomson arc circuit ammeter. This is an instrument intended for switchboard purposes and is mounted upon a black enameled metal base, with the cover, binding posts and screws of bright nickel. It measures over all 8 x 8 inches.

The qualities claimed for this instrument are its high degree of accuracy, its perfect and permanent reliability for service, together with an absolute dead-beat movement of the pointer. The scale is long and may be clearly read from a distance. One ammeter may be used for either half or full arc



THOMSON ARC CIRCUIT AMMETER.

circuit, the divisions being wide and the calibration marked for both services. Permanency of calibration is obtained by the elimination from the instrument of any parts liable to change. Each ammeter is provided with a self-contained and conspicuous polarity indicator, consisting of two signals, the white showing under normal conditions, the red or reversal, the latter remaining in sight until the current has once more passed through the instrument in the proper direction. The ammeter may be used for front or back connections, connection posts and studs being furnished as conditions require. Several of these instruments were shown at the Electrical Exposition in New York during the convention of the National Electric Light Association.

NATIONAL ELECTRIC HEADLIGHTS.

The National Electric Headlight Company, of Indianapolis, Ind., have issued a booklet of instructions to engineers for the care and handling of their electric headlights for locomotives.

The apparatus used for this headlight consists of a complete engine and dynamo plant of miniature dimensions, which is placed on the locomotive boiler between the smokestack and the headlight, and which takes steam from the locomotive. The headlight is an arc lamp of entirely special design with a view to avoiding the injurious effects of the jolting of the engine. As the current generated is only for the use of one lamp, it is of low voltage, and can be readily handled with safety on any point while running.

THE STIRLING COMPANY'S BOILER TESTS.

The Stirling Company have issued a catalogue under the title of "An Era in Boiler Performance" which describes a test made on three Stirling boilers at the Waltham (Mass.) Bleachery and Dye Works. The test data were taken simultaneously but independently by the engineers of the Bleachery Works and of the Stirling Company. The evaporation performance was high, showing an equivalent per pound of combustible from and at 212 deg. F. of 13.03 pounds of water.

An error inadvertently crept into the exhibit note of the Stirling Company in our issue of May 20. The tubes of this boiler are all expanded directly into the drums in the ordinary manner instead of being screwed in as stated. It contains no screw joints except at the steam and water connections.

PRINTING TELEGRAPHS.

The Printing Telegraph News Company, of New York City, has been organized to make, lease, sell, etc., printing tele-

graphs and other instruments used in the collection and dissemination of news. The capital is $500,000, and the officers are Orlando J. Smith, G. W. Cummings, R. W. Nelson, and John H. Grant, of New York City and M. F. Gormond, of Scraalenberg, N. J.

FIXTURES WANTED FOR THE NEW LIBRARY OF CONGRESS.

Bernard R. Green, in charge of the building for the Library of Congress, is inviting proposals until June 13, for furnishing, delivering, and putting in place electric light fixtures and lamps.

UNDERGROUND CABLE TERMINALS.

The National Underground Cable Company, of New York, Boston, Philadelphia, and Chicago, has just organized a new department for the sole manufacture of Reid tubular terminal heads and telegraph cables, said department to be under the immediate supervision of Mr. Edwin S. Reid, the inventor.

WESTERN NOTES.

THE SUNBEAM INCANDESCENT LAMP COMPANY, of Chicago, have recently received an order for their sign lamps for a large illuminated sign designed and built by E. A. Robinson, for the Hopkins Theater, Chicago. In all 400 lamps will be used. The Sunbeam sign lamps were chosen on account of their small consumption of electrical energy, and it was found that with them a better effect could be obtained than with lamps of larger candle-power, the glare of which made the letters actually less distinct, especially at a distance.

THE SIOUX CITY ELECTRICAL SUPPLY COMPANY have been obliged to increase their factory to keep up their orders for telephone goods. Among the many orders now on their books is one for 1,000 dials and automatic central switches for the Automatic Telephone Switch Company; 800 drop manual board for the Home Telephone Company, of Sioux City, to replace a board they now have; 100 drop manual board and 70 telephones for Sheldon, and 75 telephones for Sibley.

ROTH BROS. & CO., No. 30 North Market street, Chicago, report that they are very busy supplying orders for their well-known fan motors, and also for their regular make of small dynamos and electric motors. From present appearances they expect to be kept in full swing for some time to come.

THE ADAMS-BAGNALL ELECTRIC COMPANY, of Cleveland, have opened offices at suite 1654 and 1656, the Monadnock, Chicago, and have secured the services of Mr. P. H. Polglase to attend to their interests in that territory. This company were awarded the contract for 750 series arc lamps by the West Side Park Commissioners on the 18th instant, when they awarded the contract for the equipment of the new arc lighting plant in course of erection at Garfield Park. A unique feature about this contract was that their bid for it was the highest made by the competing lamp manufacturers, the lowest bid being over $8,000 under what this company entered. As is naturally to be inferred, Mr. L. H. Rogers, the general manager of the concern, who piloted this matter through so successfully, is most jubilant over his success at securing so fine an order in the face of such strong competition, and for so young a concern.

DESPITE the fact that the Central and Western States have been blessed with a delightfully cool season, the Central Electric Company's sales of fan motors are thus far away ahead of last season's output. This is accounted for by the great popularity of the Lundell fan. Old customers placed orders for these while "The frost was on the pumpkins and the fodder in the shock," and new customers ordered because of the established reputation of the Lundell fans for simplicity and beauty of workmanship. The Central Electric Company have a complete line of fans for direct and alternating currents and for desk or ceiling use. A catalogue will be sent to any address.

THE PARTRIDGE CARBON COMPANY, of Sandusky, O., are making some large carbons, 3 inches by 18 inches, for the Pittsburg Reduction Company, of Niagara Falls. They are also making probably the largest carbons ever made for the Acetylene Gas Company, of Niagara Falls, 36 x 24 x 8 inches, which weigh 400 pounds each. These carbons are claimed to be the largest ever made. The company are also making a carbon telephone powder, the tests of which have been highly satisfactory. They are constantly receiving letters from consumers of their self-lubricating brushes, among which are some of the largest concerns in the electrical field.

THE METROPOLITAN ELECTRIC COMPANY are highly elated over the success of their wonderful catalogue. They have had orders for it from Her Majesty's Government, Turkey in Asia, the gold fields of Johannesburg, Australia, Central and South America, and pretty much around the entire globe, and wherever it goes it brings the highest encomiums for its comprehensive character and attention to details. Those that are interested in electricity in any way should get a copy, as this catalogue is a great help as a "ready reference book" and an "encyclopædia of everything electrical."

THE ELECTRIC APPLIANCE COMPANY are showing a particularly satisfactory line of fan motors for the summer trade. Their line of direct current apparatus includes the celebrated Dayton ceiling fans and their own Acme 110-volt direct current desk or counter fans. In alternating apparatus they are still handling the celebrated Meston line of desk and ceiling fans.

THE MASON ELECTRIC EQUIPMENT COMPANY, the Fiberite Company, and the Lafayette Engineering and Electric Works have removed to 1202 Fisher Building, corner of Dearborn and Van Buren streets, Chicago.

NEW YORK NOTES.

MESSRS. STANLEY & PATTERSON, of 32 and 34 Frankfort street, New York, have made arrangements to act as sole selling agents in the United States for Fleming's woven wire dynamo brushes. With increased facilities for manufacturing, there will be no delay in the future in filling orders for any size of brush, or any quantities that may be required.

MR. FRED PEARCE, 79 John street, of the old firm of Pearce & Jones, has the right of sale, either goods or patent, of a covering for incandescent lamps for advertising purposes. The device consists of a truncated pyramid, the sides of which are made of variously colored mica; the one end of the device has a stationary fan blade arrangement made of aluminum. Placed on any electric light bulb the heat generated causes the pyramid to revolve, displaying the different colors and producing a strikingly novel effect. The device costs nothing to run it and is everlasting. Mr. Pearce has long been identified with the electric trade, carrying a full line of everything appertaining to electric lighting, as well as manufacturing a large number of specialties.

THE ELECTRIC ENGINEERING AND SUPPLY COMPANY, 27 Thames street, F. M. Hawkins, manager, are shipping to the Corcoran Art Gallery, Washington, a 2,000 ampere triple pole double throw switch for the extensive electric plant located there. It is of the new and improved style, as noted in their advertisement.

THE DALE MANUFACTURING COMPANY have now been located for the past few months at their new quarters, 108 Greenwich street. They are selling and manufacturing electric and combination fixtures and fittings for factories, stores and office buildings and general interior lighting. Their Mr. O'Reilly reports business brisk. This firm manufactures for the trade only.

THE WESTON ENGINE COMPANY, Painted Post, N. Y., whose works were destroyed by fire on May 16, have leased a plant in Corning, N. Y., and are carrying on their work as usual with the exception of the manufacture of engines. They expect within a very few days to complete arrangements so that they will be able to fill orders with little delay.

MR. OBERLIN SMITH, the well-known past president of the American Society of Mechanical Engineers, is bringing out, under the auspices of John Wiley & Sons, a large and interesting book on the "Press Working of Metals." It is illustrated with 433 engravings. It has 276 pages and is sold for $3. As an authority in this field, Mr. Smith is unsurpassed, and his literary ability is well known.

NEW ENGLAND NOTES.

THE BRISTOL COMPANY, Waterbury, Conn., call attention to their electrical recording instruments in a small pamphlet just published. These instruments are made in the form of ammeters, voltmeters, and wattmeters, all of which make a continuous record of the amperes, voltage or watt output of a machine for 24 hours run. As the records can easily be read down to one volt and show the exact time when any irregularities may have occurred, the use of these instruments undoubtedly induces closer attention on the part of dynamo attendants.

Department News Items will be found in advertising pages.

THE

Electrical Engineer.

Vol. XXI. JUNE 17, 1896. No. 424.

ELECTRIC LIGHTING.

THE ELECTRIC LIGHTING OF NORWICH, ENG.

THE picturesque city of Norwich, England, is successfully lighted by electricity, and the lighting plant contains several features of special interest. The scheme of lighting is carried out by the Norwich Electricity Company, a corporation which has been enabled not only to pay a dividend, but to wipe off the whole of the preliminary expenses, and carry over a respectable amount towards a reserve fund after the first year's working.

The Norwich station was designed mainly by Messrs. Laurence, Scott & Co., of Norwich, Mr. W. H. Scott, of that firm, being personally responsible for the work. The illustration, Fig. 1, is a cross section, showing the general arrangement of the engine house, boiler house, the accumulator room, and the pump house. It will be seen that the River Wensum, a navigable stream, flows by the works.

The engines, dynamos, switchboard, accumulators, condensing plant, etc., were arranged by Mr. Scott, and have been shown by experience to be admirably devised with a view, not only to facilitate working, but also to the reduction of working expenses, the best testimony for this being that the company has, as stated, paid a dividend at this early stage. The installation is on the three-wire low-tension system, the pressure at the customers' lamps being 110 volts. Accumulators are used for the lightest loads, so that the station may be shut down at night, and they are available as a standby in case of need. In designing the station it was determined to lay down six sets of engines. All are of the Willans type, and are triple-compound. Three of these engines are of 100 indicated horse-power each, and each of these engines is connected to two "Norwich" dynamos manufactured by Messrs. Laurence, Scott & Co. These dynamos will work from 110 to 130 volts. Of the remaining engines three are of 135 indicated horse-power; the dynamos which they drive—one to each engine—are also of the "Norwich" type, made by Messrs. Laurence, Scott & Co., and will work from 220 to 250 volts. A seventh Willans engine, capable of giving 200 horse-power, has been more recently added, and is now running regularly. It is also coupled to a "Norwich" dynamo.

There is a separate ejector condenser to each engine, with an alternative branch exhaust to the atmosphere, and a nine-inch water main supplying all the condensers, and receiving water from a large cast iron tank, placed over one of the coal bunkers. Korting ejectors are used and the vacuum varies from twenty inches to twenty-five inches, according to the load. Water is pumped from the river into the tank by means of centrifugal pumps driven by electric motors of the "Norwich type.

The boilers are of the Babcock & Wilcox type; they are four in number. Each of the boilers contains 1,619 square feet of heating surface and thirty feet of grate surface; the tubes are four inches in diameter, and each boiler has eight vertical sections containing nine tubes, the length of tubes being eighteen feet; the working pressure is 175 lbs. per square inch. A Babcock & Wilcox economizer is also fitted. Feed water is taken from the tank before referred to, there being also a large settling tank at a lower level, and beyond this again a smaller one, in which the water is heated by the exhaust steam from the feed pumps. One of the boilers is provided with a means for burning liquid fuel, the injector being of the Holden pattern.

The main switchboard was manufactured by Messrs. Laurence, Scott & Co. There are horizontal omnibus bars at the back of the board, which can, by means of the switches, be connected together in any suitable way. Each vertical space between the posts in the main switchboard belongs to one plant. In the center are three vertical bars connecting the three-pole switches. These are for the double dynamo plants.

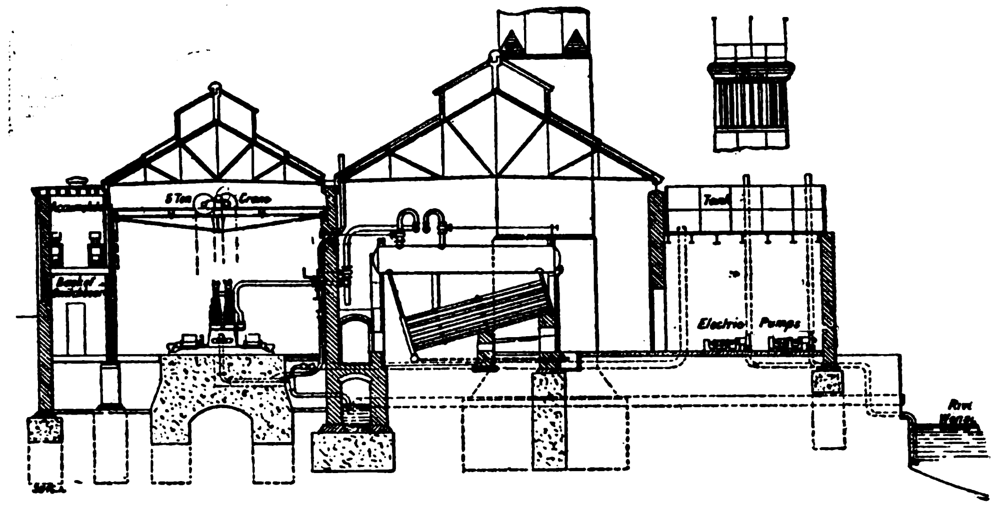


FIG. 1.—THE NORWICH, ENGLAND, ELECTRIC LIGHT STATION.—CROSS SECTION.

The current is delivered by means of feeders to three points in the city of Norwich, and when all the switches are filled in, the three tiers of switches in the switchboard will enable any of the dynamos to be switched on to any of these points.

Fig. 2 is a diagrammatic view of the connections for the accumulator switchboard. The current for charging the cells is taken off the ordinary omnibus bars and passed through the secondary winding of the armatures of the small motor dynamos. The motor winding of the armature can either be put on to the 110-volt or the 220-volt circuits through step resistances. During the early part of the charge it is a 110-volt circuit, but for the finish of the charge it has to be for a short time put on to the 220-volt circuit. This adds the extra pressure over and above the normal voltage on the mains required to charge the cells. They are charged during the daytime off the ordinary mains, a comparatively small current being used, the drop of voltage not being serious. As soon as the load comes on this charging is stopped, and as the load still increases the cells are discharged.

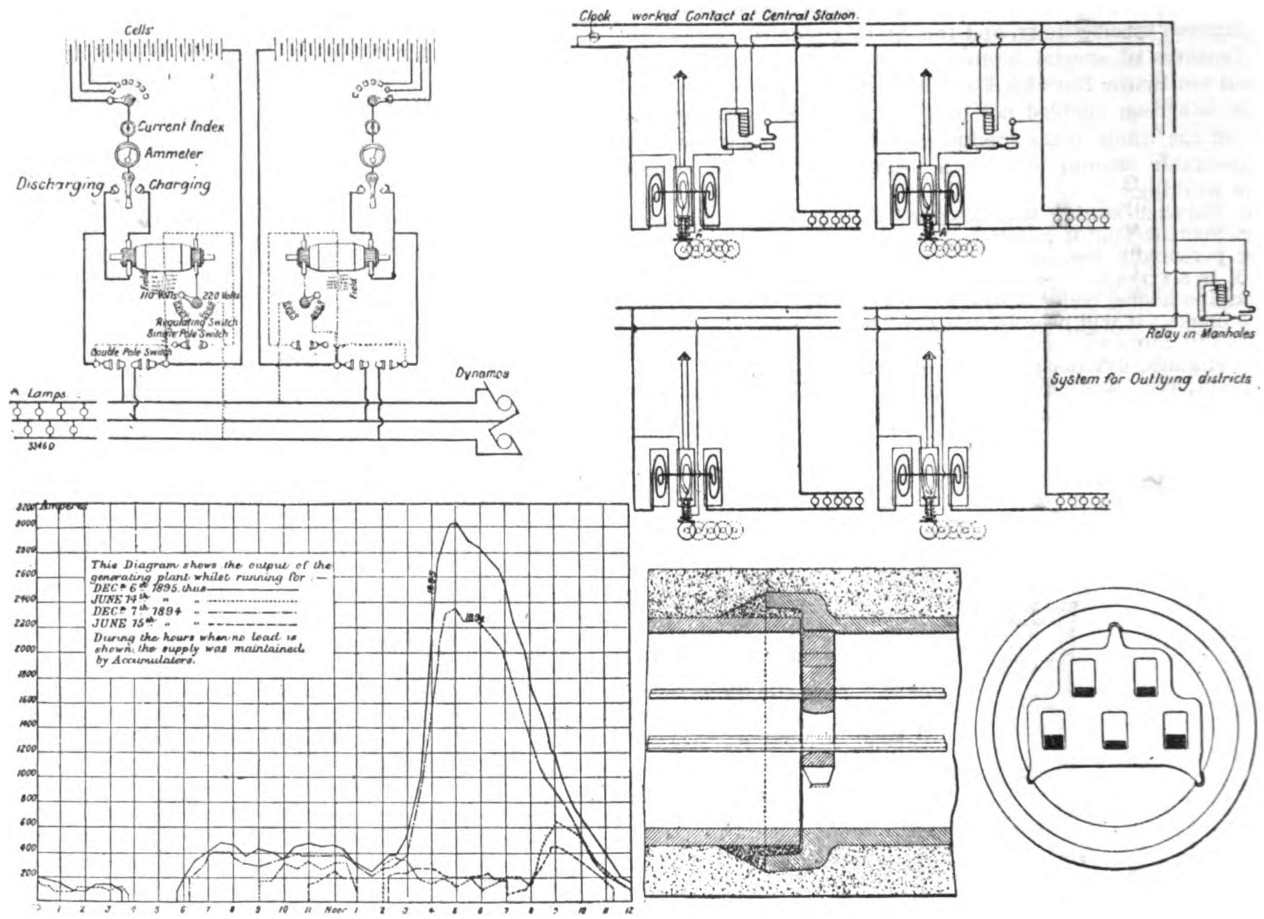
The first mains put down for the Norwich Electricity Com-

pany were on the concrete culvert system with bare copper, but during the progress of the work Mr. Scott introduced an entirely new system of bare copper culverts which has been found not only very much cheaper than the concrete culvert system, but is also claimed to be better in every way. The outline illustrations, Figs. 5 and 6, show the arrangement clearly. The high vitrified porcelain insulator is cemented, at the projecting corners only, into little nicks cut into the socket end of an ordinary sanitary drain pipe, as shown. Another length of pipe is then carefully cemented on, and the joint is cleaned inside. This forms a four-foot length of pipe with the insulator in the center. The projecting corners of the insulator are so arranged that the surface of contact with the pipe is very small, while there is ample space under the insulator for water to drain away and to allow for sag of the copper strips. Six-inch pipes are used for the ordinary distributing mains. These are threaded through the holes in the insulators, as shown in Figs. 5 and 6. The insulators for nine-inch pipes have five ducts or ways, three for distribution, and two for feeders, as shown in Fig. 6. The copper is not drawn in until after the conduit has been put down and finished, but draw wires are pulled in by means of long splines, one for each way. To put the copper in place a steel cable is pulled in by means of the draw wire, and with this cable—by means of a special connection—the copper strip is got into position without any difficulty.

Mr. Scott was an early advocate of the use of continuous current transformers for electrical distribution, but after studying them from every point of view, he now maintains that for ordinary town distribution they are not desirable. He holds that if the cost of the transformers, and of the highly insulated cables required for conveying the current to them, be put into bare copper and culverts, the same efficiency at full load can be obtained in practically every instance. This means a much greater all-round efficiency, as the loss in the simple conductors is reduced in proportion to the load. The up-keep depreciation is very much less with a simple heavy copper conductor, and, most important of all, the reliability is very much greater. These considerations have led Mr. Scott to condemn the continuous current transformer for ordinary distribution.

For obtaining the extra electromotive force for enabling the accumulator cells to be charged at points distant from the central station, however, he has found a modification of the continuous current transformer to come in very useful. The pressure can be raised from below the standard lamp voltage to the required amount for charging the cells. In order that the lamp voltage near the transformer station shall not be lowered during the time of charging, a feeder is taken back to a point near the feeding point from the central station. The current for charging the cells is then taken along this charging feeder, the slight drop in it being made up by the transformer.

An entirely novel arrangement of meters and system of charging for current has been arranged for the Norwich installation, and has been in actual working for over two years. Between an hour before sunset and eight o'clock in the evening the Norwich Electricity Company's charge for current for lighting is 8d. per unit. At all other times it is 4d. For motors it is 6d. and 3d. for the periods named respectively, except for large motors running continuously all day, for which only 3d. is charged throughout. This differential charge is rendered possible by the meters being arranged to integrate only half the amount of current supplied between 8 o'clock in the evening and an hour before sunset the next day. At other times the meters integrate the full amount of current supplied. To effect this the meters are of the periodically integrating type, and consist of a shunt coil hung between two fixed series coils through which the current to the lamps passes, as shown in the diagram, Fig. 3. This shunt coil is excited periodically, and as long as the current flows in it, it is deflected an amount exactly in proportion to the watts in the circuit which it is metering, falling back to zero every time the shunt circuit is broken. It is clear, then, that if this periodic deflection is made to move a train of wheels, the train can be so arranged that the meter will indicate the exact amount of electricity used. To do this it is necessary that only one movement (either the forward movement of the coil or its backward movement) should move the train round. This is effected by a little friction pad which is lifted by the little magnet A. so that it does not bear on the friction wheel whilst the shunt current is flowing. On the shunt circuit being broken, however, this little pad is dropped on to the friction wheel which forms the first wheel of the integrating train. This wheel is



FIGS. 2, 3, 4, 5 AND 6.—THE NORWICH, ENGLAND, ELECTRIC LIGHT STATION. DETAILS OF CONSTRUCTION AND OPERATION.

thus moved round every period an amount exactly in proportion to the amount that the shunt coil was displaced, owing to the electro-dynamic action of the currents in the wattmeter.

This meter, of course, requires some arrangement for making and breaking the shunt circuit periodically. This is done in the majority of meters in Norwich by means of a relay in the meter. These relays are in series on different circuits which radiate from the central station, the conductor for these circuits being in an iron pipe which is laid alongside the earthenware pipe culverts. The meters are so calibrated that if the shunt circuit is completed once every ninety seconds they will integrate exactly in Board of Trade units, and it is evident that if this impulse is sent only once in 180 seconds they will indicate only half the current which has passed through them. The differential charge is arranged in the following manner. There is a special clock at the central station which is set to automatically change the rate from 90 to 180 seconds, at an hour before sunset, and to change over again at 8 o'clock in the evening and 7 o'clock on Sundays. The adjustments are made, according to the calendar, at any time during the day. The clock automatically carries out the rest of the work.

The advantages of this system over other differential systems are twofold. Firstly, there is no complication in the accounts, which are simply rendered according to the meter readings at 8d. per Board of Trade unit; and, secondly, that customers get charged for their current as nearly as possible in the same proportion it costs the company to supply it. Thus, offices, shops that close early, etc., which only require light some 150 to 200 hours per annum, and always take their light at the time of maximum load, are charged at the comparatively high rate of 8d. per unit. Before 8 o'clock in the evening the maximum load has gone off, and the station has ample reserve, so that any additional customers that come on only at this time do not increase the capital charges. Further, places of entertainment, churches, etc., although their number of hours running is small, can yet be supplied profitably at a very cheap rate. They get nearly all their supply at 4d. per unit, while those who require light from dusk till, say, 11 o'clock at night, such as clubs, public houses, etc., get their supply at an average rate which diminishes according to the increase of the number of hours that they require light per annum. These are just the customers that are most profitable to an electric lighting company, even at a very reduced rate.

The Norwich Electricity Company have been at work sufficiently long to thoroughly test the design and workmanship of the plant, and the result appears to have been most gratifying, both to those who were responsible for the designing and construction of the arrangements, and to the shareholders of the supply company, and to Mr. F. M. Long, the managing engineer of the company, who has had charge from the beginning both of the installation of the work and the running of the station.

The works' cost of the electricity supply during the year 1894 came out 2.19d. per unit, and during 1895 at 1.90d. per unit. This was including the coal, oil, waste, and other stores, salaries of engineers, and wages, repairs, and maintenance, including also maintenance of mains and other distributing expenses. The coal, oil, waste, etc., came to 1.28d. per unit in 1894, and in 1895 to 1.01d. In considering these figures it must be remembered that Norwich is a long way from the coal districts, the average price paid for fuel being some 16s. per ton.

In Fig. 4 we give a diagram showing the load for two midsummer and two midwinter days in 1894 and 1895. This will be of interest to those of our readers who are engaged in similar work.

From figures submitted by those engaged in the work, it would appear that on the first year's working (1894) a profit of £1,813 was made, the revenue from sale of current and meter rents being £3,790. For the year 1895 a profit of £2,998 was made, with a revenue of £5,845. The profit for the last year was just 5½ per cent. on the capital expenditure.—Abstract from "Engineering."

A Day with the Founders of Ampere.

BY

T. C. Martin

I.

In the early eighties, the present writer, in the performance of editorial duties, happened to hear that two young fellows, fresh from Columbia College, had taken up the then novel problems of electric motor building, and were actually ready to sell motors of an efficiency that was remarkably high for the times. A visit to a small office room in the Tribune Building was enough to prove that a distinctively new departure was being made, and that these two enthusiastic youths, whose engineering skill and training were reinforced by special aptitude and peculiar foresight, had designed a motor of remarkable qualities. As a matter of fact there were three Columbia graduates interested and contributing, namely, C. G. Curtis, F. B. Crocker and S. S. Wheeler, and it is but simple justice to say that the work of those three young men is part of the solid foundation upon which the great motor industry of to-day has been reared. Up to that time, motors were, as a general thing, fearfully and wonderfully built, and, according to some figures made by Mr. Edward Weston, then,

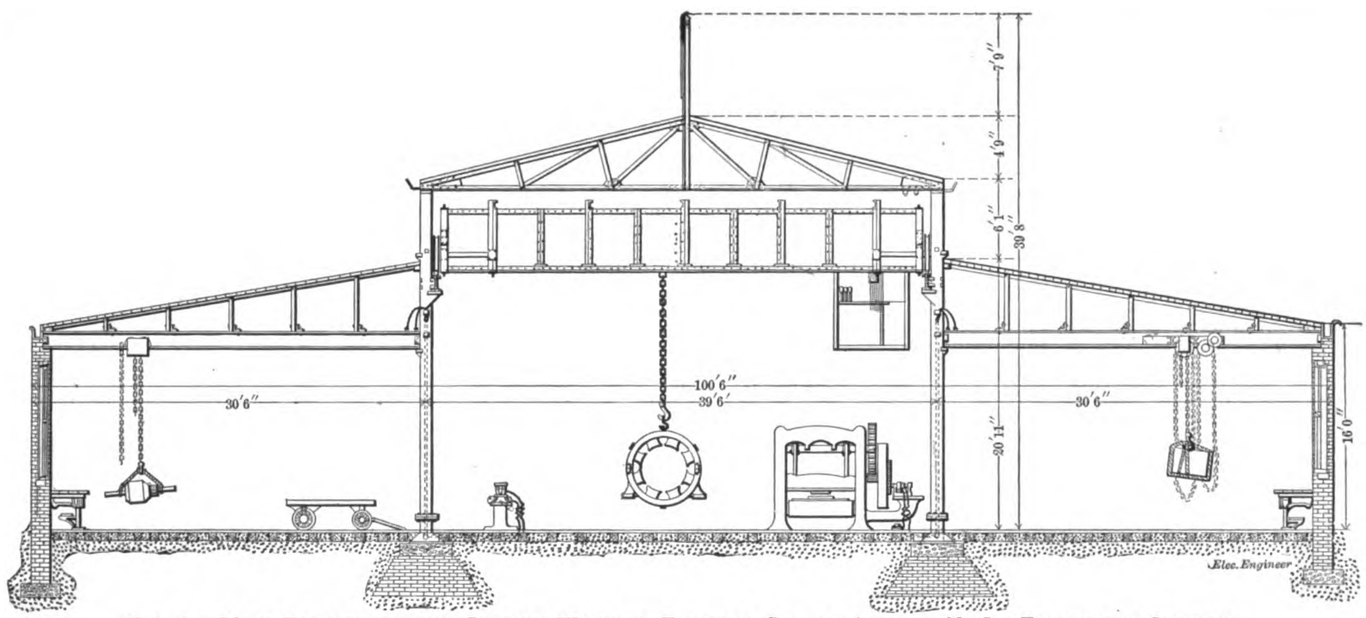


FIG. 2.—MAIN FACTORY OF THE CROCKER-WHEELER ELECTRIC CO., AT AMPERE, N. J.—TRANSVERSE SECTION.

as now, a leader in the electrical arts of construction and measurement, there was not one on the market that had an efficiency of more than 16 per cent. They were all small and all of delicate constitution. Almost all of them were designed to run on battery current, and even the three motor "musketeers" named above counted it no mean thing to have improved on the methods of supplying and replenishing the electric "growler" or battery jar. But the chief idea of Messrs. Curtis, Crocker and Wheeler was that the central station circuits would in time multiply and ramify like water pipes, and Mr. Wheeler, who had done pioneer work in the lighting field and on the Edison mains in New York and other cities, was tenacious in his belief that the thing to strive for was a motor that could be clapped on the circuits just as easily as a lamp.

Nearly fifteen years have rolled by, with tremendous and kaleidoscopic—or even kinetoscopic—changes in the electrical field. It is above all things true that the electric power art has gained an enormous ascendency, and has begun to split up into a number of new departments, each of which is a differentiation from the common stock. The lighting art has not waned but waxed; yet there has grown upon the electrical consciousness the conviction that as lighting lasts but a few hours in the twenty-four, while power may be needed every second in the day, it might be well to devote to the motor some of the energies hitherto concentrated on the lamp alone. Putting aside the electric railway industry, as an art now altogether apart, we may safely say that the chief opportunity for the sale of current to-day lies in the installation of motors; and thus we find justified the early optimism of which brief mention has been made above. It is seldom given to a pioneer or forerunner to see the accomplishment of his plans and dreams, and it is therefore noteworthy that, amidst all the changes and vicissitudes of the growth of the motor business, those who had so much to do with its inception have played a leading part. Dr. Wheeler helped to give New York her subways; Professor Crocker is at the head of the electrical studies in Columbia, but their united names remain associated with the great motor-building art and with one of the largest electrical factories in the United States.

II.

If the Greater New York were to include all the territory that honestly belonged to it, part of Connecticut and half of New Jersey would be under the rule of her City Hall. Hence the pretty little suburb of Ampere is as much a part of the metropolis as Broadway, and it is as easy to reach it as Central Park or Grant's tomb. It is now some years since a rap-

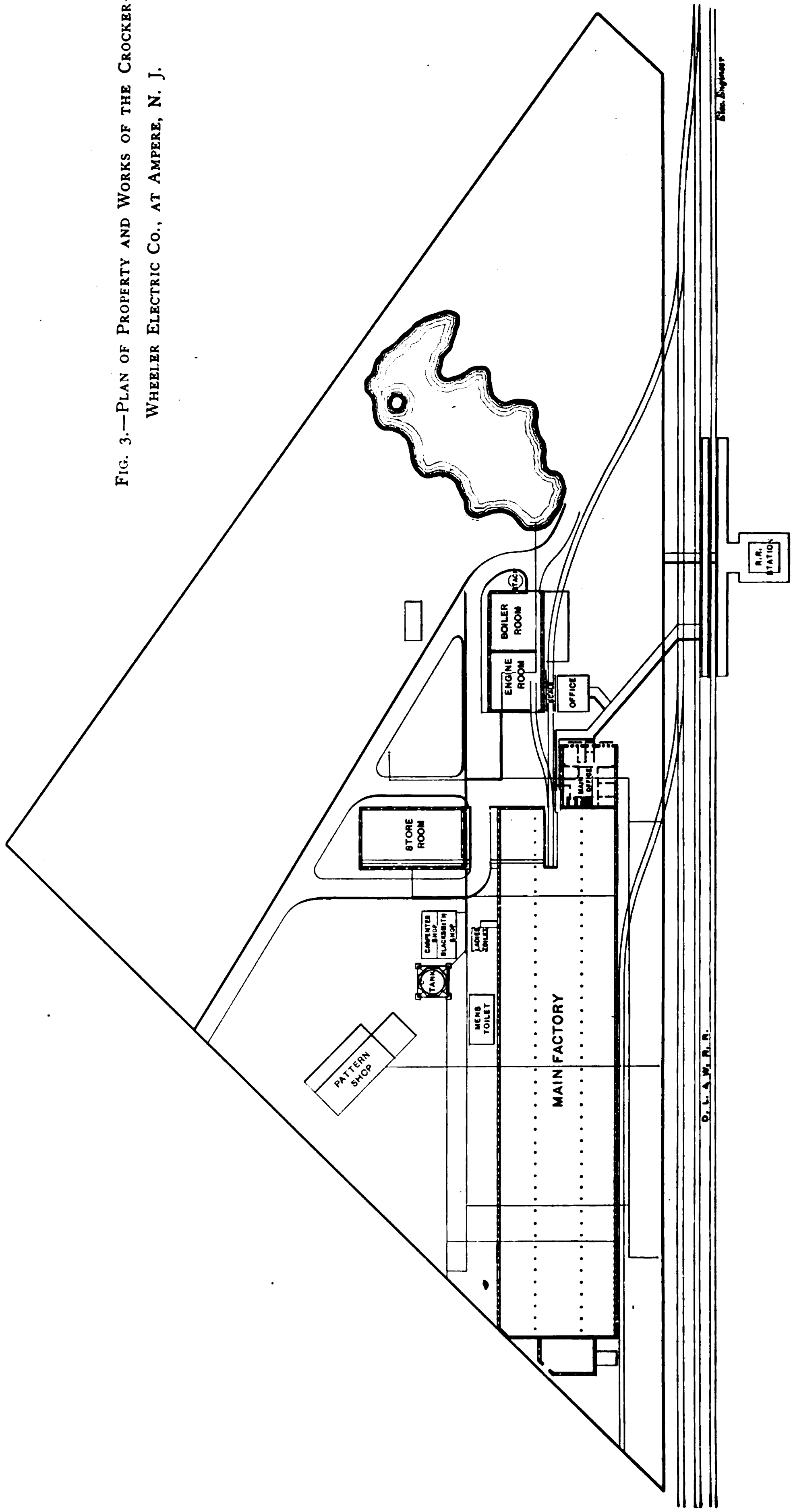
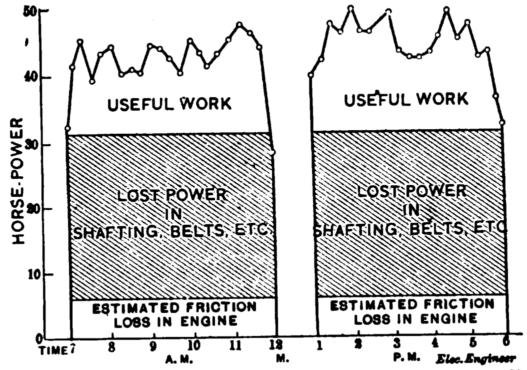
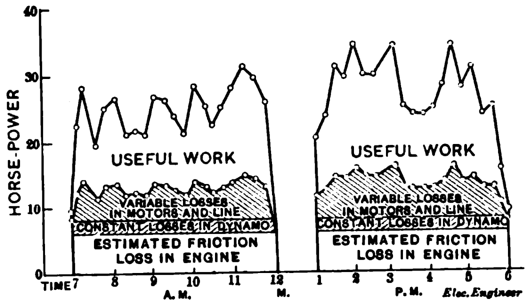


Fig. 3.—Plan of Property and Works of the Crocker-Wheeler Electric Co., at Ampere, N. J.

idly growing demand for their product caused the Crocker-Wheeler Electric Company, after several expansions in the city, to remove their works to the Jersey suburb, where the railroad opened a station for them, to which they at once gave



Power Test, Factory "K," Central Stamping Co., Brooklyn, N. Y. Average I. H. P., 44.1.



Losses in Same Plant with Electric Transmission. Average I. H. P., 25.7.

Fig. 4.

the name of the famous French physicist. There they took possession of works that were well adapted to their purpose, though not specially designed. The main advantage was that the company, which at an early stage of its career had turned out fan motors by the thousand, now found itself swamped with orders for "power" motors in equal number and often in very large sizes, and it was able here to meet just such demands.

One of the main features of the factory was the demonstration of the ease and facility with which it could be operated by the direct application of electric power. Reference to this was made from time to time in the columns of The Electrical Engineer, to which Dr. Wheeler also furnished a valuable series of articles on motor-driven tools. To-day the subject is well within the range of "practical politics," but at that time the argument had to be made from the ground up, and a vital, typical example, such as this factory presented, was of inestimable importance in shaping public opinion and determining the shape of events.

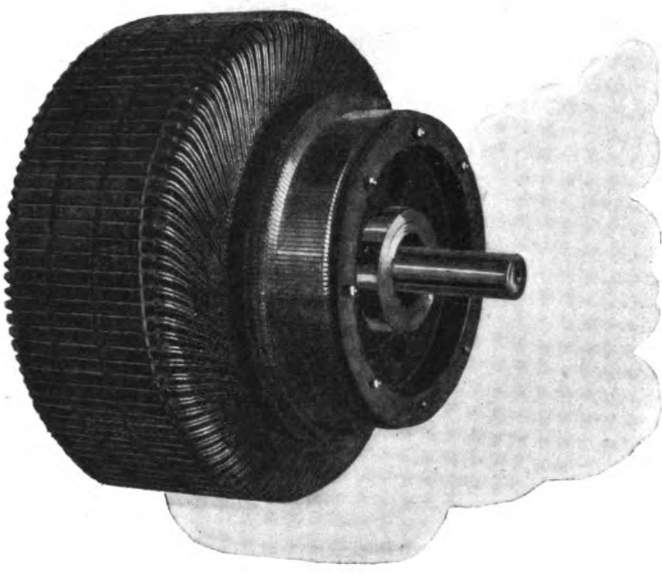


Fig. 6.—Armature for Direct Connection on Engine Shaft.

Early in 1895, just when the company was loaded down with orders and contracts for spring delivery, the factory was destroyed by fire. It was a Sunday, when nobody but the watchman was around, but that only helped the progress of the flames; and in a few brief minutes everything was in wreck and ruin. President Wheeler received the news at a time of bitter domestic affliction in the loss of his wife, whose interest in the factory had been as devoted as his own.

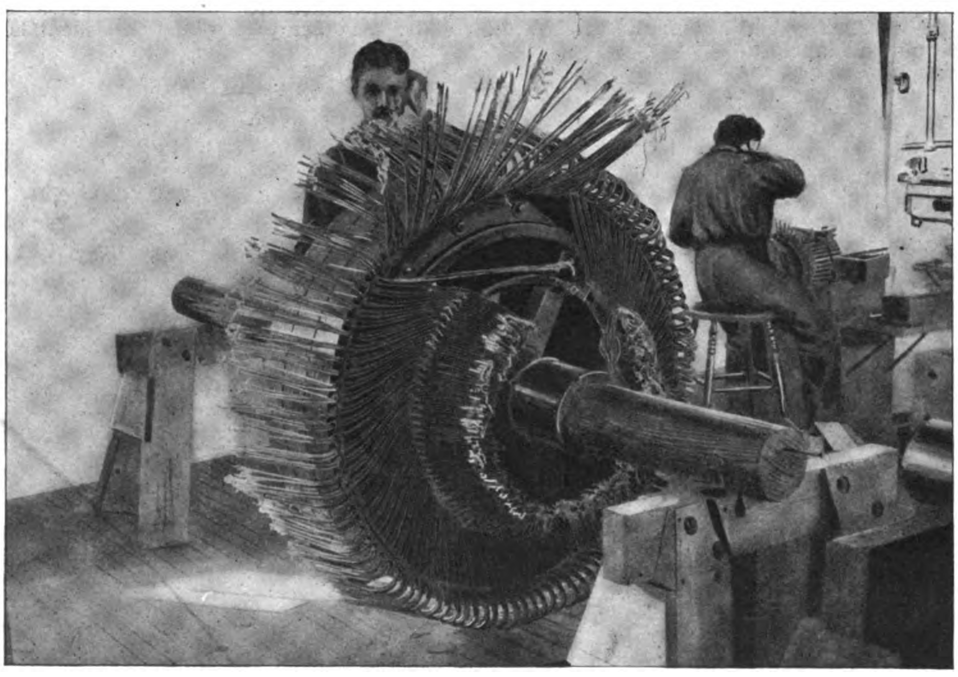


Fig. 5.—"Direct Connected Type" Armature Core, Partially Wound.

III.

Within a week after this disastrous fire, the insurance was adjusted, and the work of restoration began. Part of the old main shop was patched up, the summer weather was favorable,

motors were hitched on to available machinery, gangs of workmen were employed night and day, and within three months the company had emerged from chaos and was again abreast of its orders. But the necessity for a new factory was imperative, and by dint of strenuous effort new shops and a fine new office building were completed by the end of the year, the officers and engineering staff acting as architects. It is obvious that while the fire had been a severe blow, it also permitted the executive of the company to carry out with more vigor and thoroughness than ever its rooted ideas as to the use of electric power in a factory.

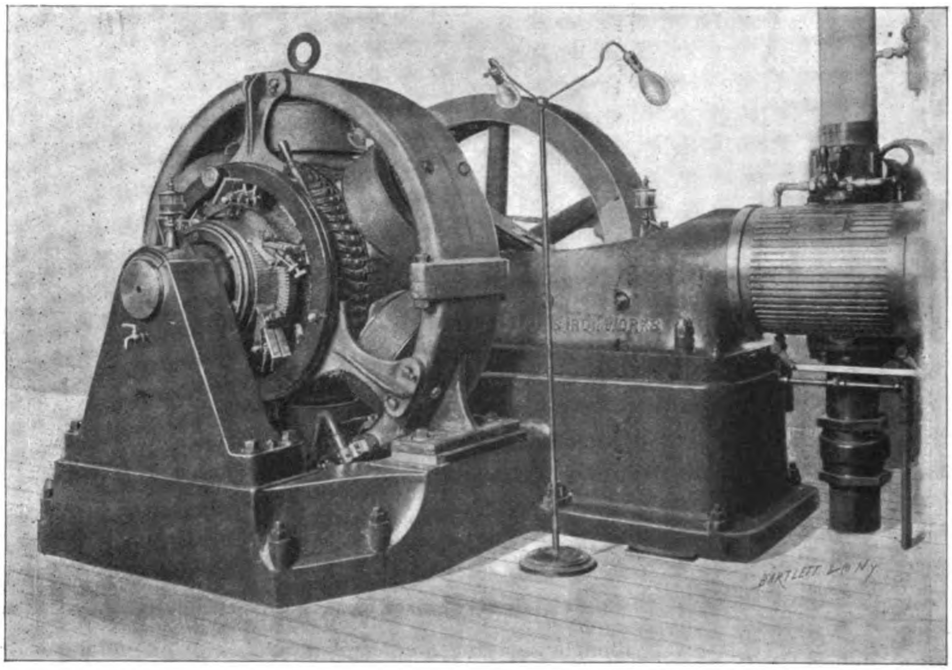


Fig. 7.—Dynamo, Direct Connected to Shaft of 80 Horse-Power Engine.

In some respects the old factory had had merits in showing how electric power could be adapted to conditions, all of which were not favorable, but in the new factory the conditions could be molded so as to satisfy any one that a manufacturer who did not equip with electric motors was limiting himself in the quantity and quality of his output.

The new factory, to which the present article is devoted occupies the same situation relatively as the old one, being only eleven miles from New York City on the Montclair branch of the Delaware, Lackawanna & Western Railroad, beside which the buildings align, and from and to which cars are directly switched, while a passenger service of twenty-five trains daily each way renders access easy alike to visitors and to the staff of the selling department in Cortlandt street.

Electrical factories have long ceased to be a novelty, and the public is now familiar with their main processes, all of which bear a family likeness; but a good deal that is of interest can be learned at any time from the study of a typical establishment, and especially from a well conducted place where new things are continually being tried. The new Crocker-Wheeler factory may be taken up in three sections, namely, the office building, the power house and the shops proper. Each of these departments is in evidence in the fine supplement accompanying this issue of The Electrical Engineer, and each will be later considered in detail. It may be said in passing that the view of the works from any point of the surrounding country is very attractive and imposing, the offices and power plant first catching the eye, and then the long main shop. The length of the property is, in fact, such as to have rendered difficult the securing of the large photograph from which the engraving in our supplement is taken.

IV.

The office building is a solid, handsome structure in red brick and stone, 50 feet by 47 and 45 feet high, four stories, and has been designed throughout with special reference to smooth management of the works and to facilitating the work of the engineering and drafting departments. On the main floor, on the left, as one enters, is a convenient suite of offices, where President Wheeler and his staff may be found. Across the hall are the treasurer's office and bookkeeping department. The chief engineer, in direct touch with Dr. Wheeler, has his office also on this floor, and the workmen's entrance to the shops in the rear is so arranged that all pass through the bookkeeper's office and are registered or paid without any disturbance of the quiet, orderly routine of the place. On the second floor are drafting, blueprinting and photographer's rooms, while provision has also been made for a fine library, lavatory, locker rooms, etc. Above this floor is another devoted to minor uses, including storage of plans, office material, etc. Descending the stairway to the basement, a large portion is seen to be given up to the laboratory and experimental testing work in charge of Mr. Dunn. Any work brought here can be attended to without derangement of the shops. Some of us have often seen a whole factory "stood on its head," while a small experiment was being tried, but here the division between apparatus for test and apparatus for sale is absolute. Every care has been taken to provide facilities and insure accurate results. Another part of this basement is occupied by the bicycle room. At one side it communicates by tunnel subway with the power house, whose circuits run to it, and on the other side the tunnel is continued so that the conductors reach the main shop and there fan out for the delivery of their current.

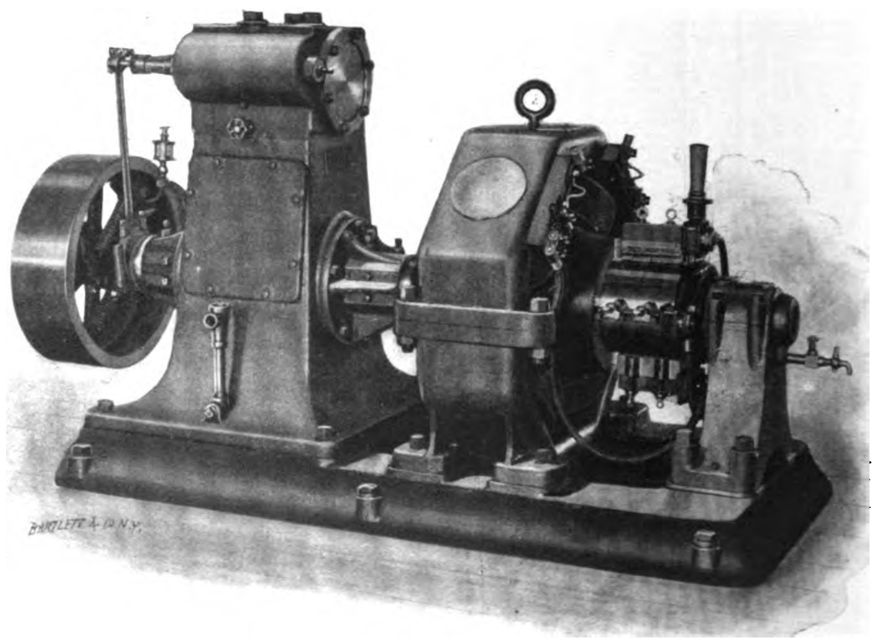


Fig. 8.—Generator, Direct Connected to Case Engine.

Provision has also been made in this building for the preservation of records. A fireproof chamber, about ten feet

square, runs up through all the floors, surrounded by air spaces and protected by brick arching. Here, in these safety vaults the papers and records of each department are put. The whole interior construction of the building is of the slow-burning type and it is provided with sprinklers throughout.

V.

The power plant of these extensive works is smaller than one would imagine or expect, but herein lies one of its chief beauties in the eyes of the company's officers, who point to it as a concrete example and embodiment of their theories as to the economical generation and consumption of power when electricity is the distributing agent and motors are the translating devices at the point of consumption. In the boiler room there are three ordinary boilers, each of 125 horse-power, the steam room being separated from the dynamo room by a short flight of stairs and a dividing wall. Only one boiler is used at a time. In the dynamo room, conveniently disposed, is, first, a fine Hewes & Phillips Corliss engine of 125 horse-power, belted to an 80 kilowatt Crocker-Wheeler generator. Then comes a McIntosh & Seymour high-speed engine of 250 revolutions, direct connected, to a 100 k. w. C. W. generator at 110 volts, and also belted in tandem to an 80 kilowatt, 220 volts, and a an 80 kilowatt, 500 volts, these three making a complete outfit for current for testing at the standard American voltages. Besides these engines, there is an Ames of 40 horse-power intended presently to run direct connected, but just now belted to a 25 horse-power Crocker-Wheeler dynamo for night work. At one end of the room is a neat slate switchboard, to which all the circuits are led, for connection to the subway, entrance to which is made by a stairway at its rear. Extending over all the machinery is a traveling crane supported on the roof trusses for handling machinery.

In connection with the power plant must be mentioned the fire equipment, one notable item of which is the Standard Worthington fire pump, capable of sending out four full streams. The conspicuous water tower and tank, standing fifty feet high, is of 32,000 gallons capacity. The well is 231 feet deep, 8 inches in diameter, equipped with a deep well pump 75 feet down, operated by a 2 horse-power C. W. motor. This combination gives a yield of 1,500 gallons per hour in the tank. The water rises naturally to within twenty feet of the surface of the well.

There are seven fire hydrants on the grounds connected to the tank and the fire pump. With the pump not in action, the tank will supply the hydrants for one and one-half hours.

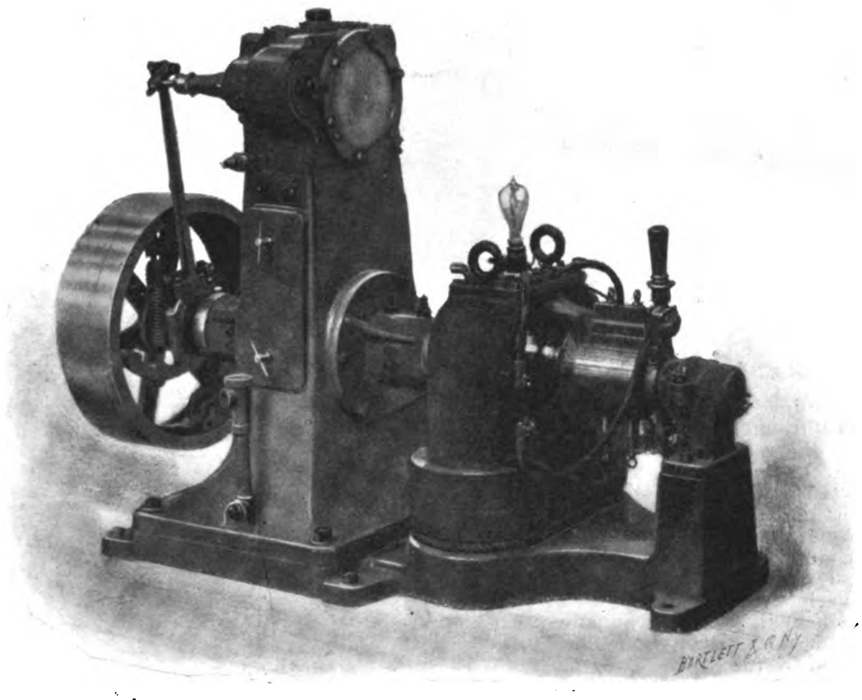


FIG. 9.—GENERATOR, 4 KILOWATTS, DIRECT CONNECTED TO ENGINE.

Throughout the buildings there are no fewer than 1,500 standard sprinkler heads, and the tank is fifteen feet above the highest of them. The tank is connected to the sprinkler system and the hydrants by several discharge pipes.

Returning to the subway at the back of the power house switchboard, it will be noted by an observant visitor that it slopes somewhat toward the foot of the engine room stairs. This is done for drainage purposes, should any water get loose anywhere, and there is a steam siphon to blow off any such liquid intruder. The subway system is wide enough and high enough to walk through, the conductors being carried on the side wall until they reach a manhole under the shop floor, the steam heating pipes being supported on the opposite wall. When they reach the shops the conductors travel along the tops of the roof trusses, on ordinary glass line insulators, the steel shanks of which are bolted directly on to the trusses. It would be difficult to devise a better or more simple method of interior distribution for this class of work.

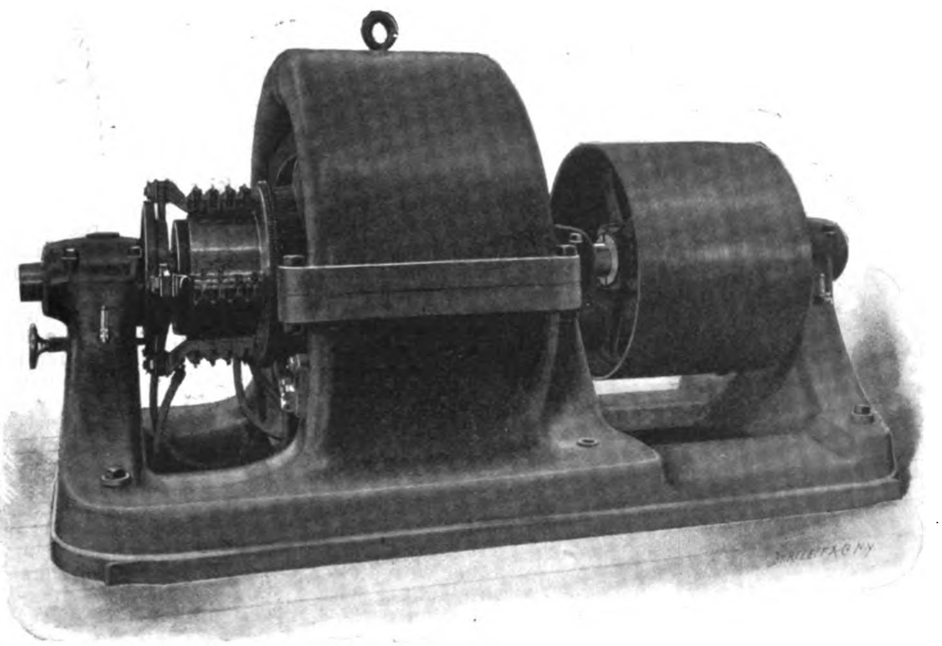


FIG. 10.—250 HORSE-POWER MOTOR. WEIGHT, 15 TONS.

VI.

As part of the power house and testing service, it should be mentioned here that the wiring consists of three pairs of cables running from the switchboard to the testing room in the main building with branches to the laboratory in the office basement, these three pairs furnishing the three separate voltages, supplemented by suitable circuits for controlling the fields of the dynamos. In addition to this, there is the regular wiring for the office building in tubes, and there is also the shop wiring. The latter consists of one pair of cables reaching from the switchboard to about the centre of the shop and terminating on an ordinary slate panel board where there are

fuses through which four circuits run to the four quarters of the main shop building, and two cicuits to the outlying buildings.

The taps for lighting and power are taken off through porce-

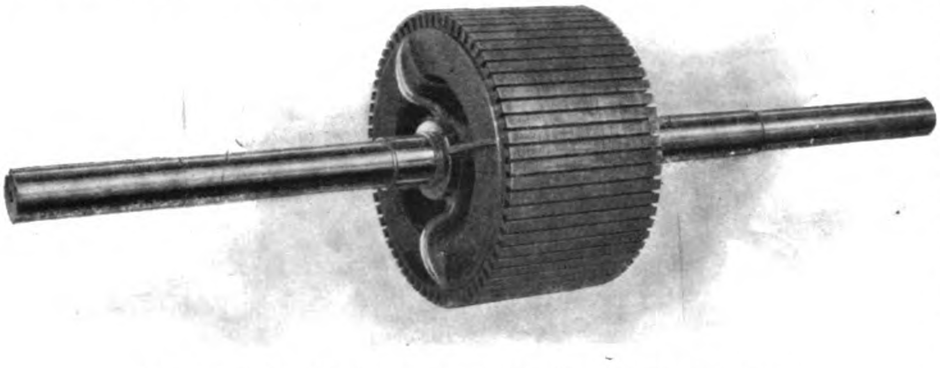


FIG. 12.—CORE AND SHAFT RING-TYPE WIRE-WOUND ARMATURE.

lain fuse blocks attached to the iron columns of the shop, and thence through small holes in the columns and down the inside of the columns to a point below the surface of the floor, where they come out through other holes cast like those just described above, in the bases of the columns. They now, at the base, enter wooden troughs laid under the floor in the cement. They come up through the floor at various points where desired, through small auger holes made directly under the different machines to be operated by the "juice."

VII.

The main shop building is of interest, not alone to electrical engineers. It is a low-lying but striking edifice, with a remarkably busy and business-like air about it. It is 450 feet long and 100 feet wide, and if we add fifty feet for the office building, to which it is closely joined, the front presented is full 500 feet in length. The ridge pole from one end to the other is followed by a huge sign, eight feet in height, and legible at a great distance. This sign is massively supported by the king posts of the roof trusses, which were extended upward through the roof for the purpose. Seen at a remove of a few hundred yards, the factory appears to be closely environed by green fields, but an inspection near at hand re-

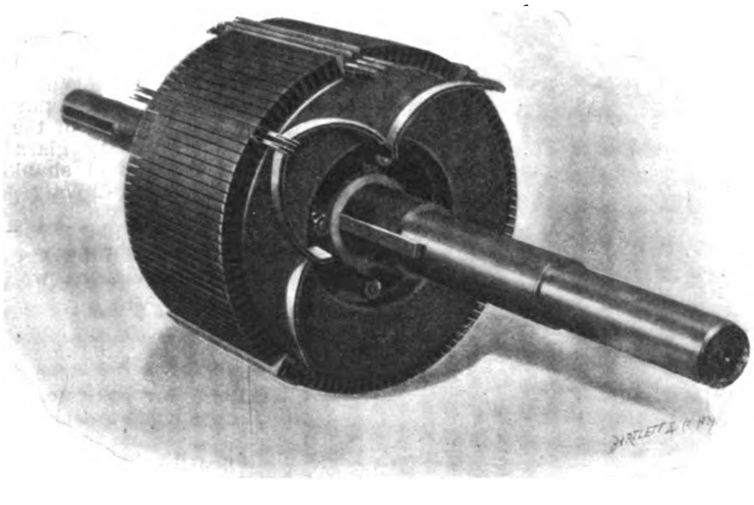


FIG. 14.—TWO-CIRCUIT BAR-WOUND ARMATURE, SHOWING CONNECTION DETAILS.

veals the railroad tracks and switches, one of which passes over a railroad scale and then into the building, where the traveling crane meets and extends over it.

There are many special features about the construction of the building, whose architects and engineers have realized that it is the first of its kind where sundry contradictory conditions had to be harmonized and turned into advantages with the aid of electricity. For example, the item of the floor involved many considerations of novelty. It was decided to put down a floor that in itself would be heavy enough to serve as a foundation for any machinery, so as to obviate both the cutting up of the floor for masonry and to facilitate the hauling around of the heaviest loads on plain roller trucks without laying industrial tracks on it for hand cars. As a result the floor is like rock. It is built up of 4 inch by 6 inch chestnut sleepers, laid in Portland cement concrete. Over this is a finishing coat laid on with the trowel and top dressed with tar. On this again is laid two-inch spruce planking and above it one and one-half-inch finished maple. Objection might be raised with some reason to the risk taken of damaging the surface of such a floor by heavy stuff, but it must not be forgotten that the electric overhead crane provides an aerial trolley system for just such material; hence the floor remains in good condition all the time.

The whole floor is most beautifully lighted up by means of

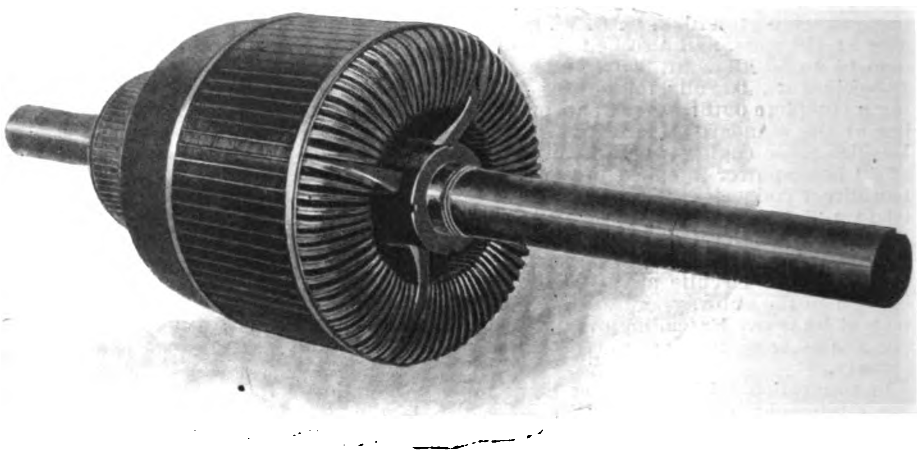
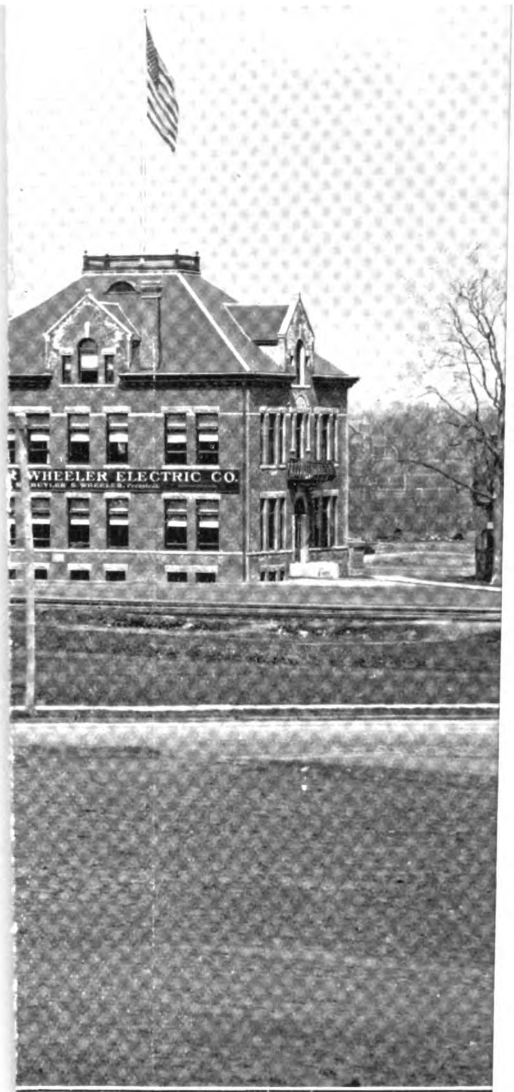


FIG. 13.—RING-TYPE COMPLETED ARMATURE.

its large side windows and its ample monitor roof, but other modifications in ordinary factory structure have been introduced, tending to strength and lightness. The usual construction of the side trusses of a roof was varied with the object of furnishing trusses, the lower members of which could support trolleys for hoists having a capacity up to four tons. By the employment of fifteen-inch light beams, for the under members of the lean-to trusses and a very light angle iron for the upper members supported by vertical pieces of angles iron, the roof trusses were made with a very little increase of weight, yet with a lower member that would easily carry a large and powerful hand hoist. These roof trusses are ten feet apart. The transverse sectional cut of the main building shown on one of these pages illustrates admirably the features of the central traveling crane and the side hoists, in their relation to the trusses and as regards their own proper functions. It is certainly not the least interesting and instructive thing in the worlu to see the electric crane traveling from one end of the shop to the other with a twenty-foot lathe, like a lion making off jauntily with a young calf in its jaws. The amusing part of this performance is to see the lathe go on with its work. The little motor running it is in the bed, under the headstock and is geared directly to the main spindle and current reaches it in this position from the crane trolley. While in this attitude the lathe will turn off a piece of steel shafting of its full capacity, and will go on with the work quite nonchalantly, the spiral of cutting simply curling off to the floor. Paring apples for dinner in a balloon or peeling potatoes under water could hardly be more unusual and spectacular, but such things help to convey to many people of



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lethargic imagination the ideal of what is possible and feasible.

VIII.

The main shop is, of course, properly divided up into sections. On one side a large amount of building up and special tool and machine work is done, as the cuts in our insert show. At the centre of the floor is a store room of the most liberal character, divided into groups and copiously supplied with every detail. At the end furthest from the office building, a gang of motor-driven punches and stamps prepare armature discs and other sheet metal for use, and all along the eastern side are armature winders, banks for testing, machines for turning brass screws and binding posts; and all the facilities for assembling generators, motors, rheostats, starting boxes and the other parts necessary for the operation of the apparatus. The scene is always animated to a degree. Going around, one notices an ingenious system of "Works Orders" in use, with which to identify and follow up the work. Every piece of work carries the details and certificate of its birth in a little bag tied around its neck. No matter what it may be, each piece of work going through the shops has its special "Works Order" made for it very fully and very descriptively, by the assistant engineer, who has charge of the records and specifications. In the case of a single piece of apparatus, this blue envelope with brass tag may be seen attached to it wherever it may be in any part of the shop. In the case of a batch, the envelope goes with the crowd, so to speak. It is not to be imagined that the works order is a brief outline; it is more like the patent specification which any intelligent workman is supposed to be able to take and interpret fully by himself.

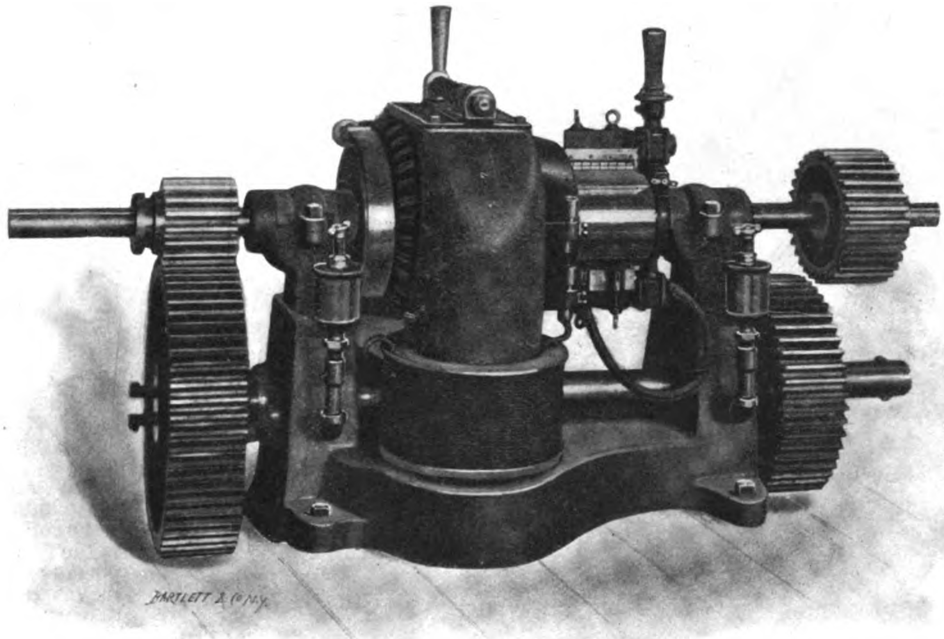

FIG. 15.—10 HORSE-POWER AUTOMATIC BRAKE MOTOR FOR OVERHEAD CRANES.

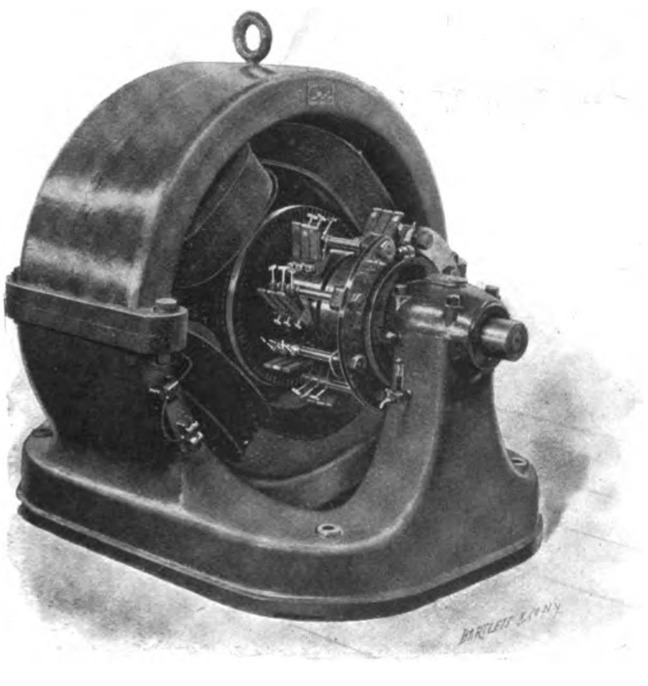

FIG. 11.—100 HORSE-POWER DYNAMO, WEIGHT, 16 TONS.

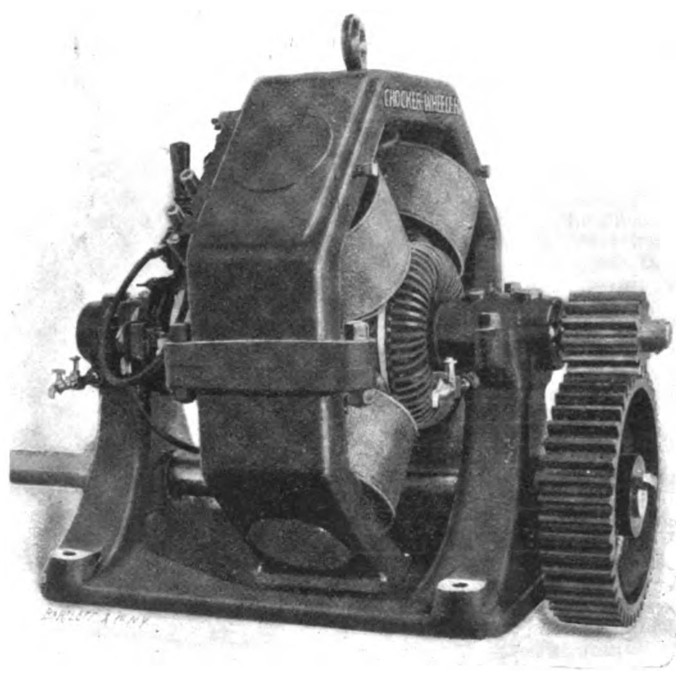

FIG. 16.—15 HORSE-POWER SINGLE-REDUCTION GEARED MOTOR.

"Shipping Orders" are, of course, a very important and separate detail. This part of the work is managed from the headquarters in Cortlandt street, but by means of the telephone line an extra shipping number can be obtained at once if necessary for some special thing and the goods may then be sent out.

These orders all emanate thus from one desk, in charge of Miss Hamilton, the experienced order clerk, and to that desk everybody concerned in the shipment of the goods is responsible for their dispatch.

Outside the main shop there are a number of supplementary and subsidiary buildings and departments, such as the pattern shop, carpenter shop, buffing shop, forging shop, etc. In all of them the leading principle and idea is to drive the tools by motor, so that the absence of belts, shafting and pulleys which at first struck the casual visitor as a curious thing soon comes to be accepted as the right and only way.

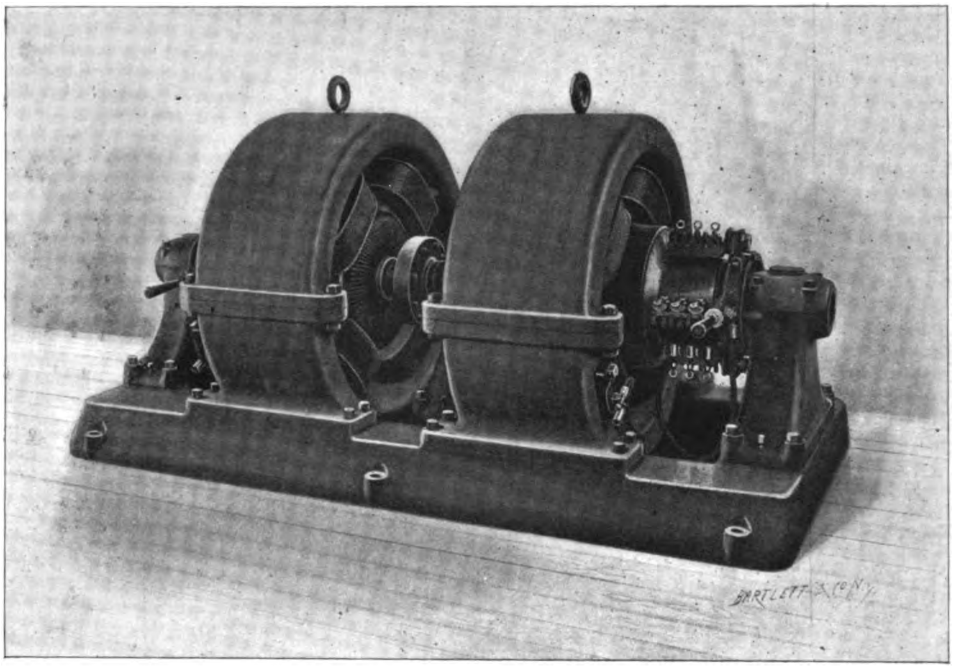

FIG. 17.—100 HORSE-POWER "BOOSTER" FOR RAIL WELDING.

IX.

Before passing on to a brief notice of a few of the direct-driven appliances and the generating apparatus built by the Crocker-Wheeler Company, it may be well to note, even at the risk of tiresome iteration, the principle upon which their applications of electric power are based and upon which they are now rearing one of the standard electrical industries of the country. The electrical reader of this journal is familiar, doubtless, with the proposition, but that it still needs lots of missionary work is evidenced by the literature recently issued by one of the foremost engineering concerns in the country, offering its services in special installations of long rope drives for power transmission in mills and factories. The very cuts they use are calculated to make an electrical power engineer rub his eyes in astonishment and wonder whether this famous house may not have been indulging in a Rip Van Winkle sleep.

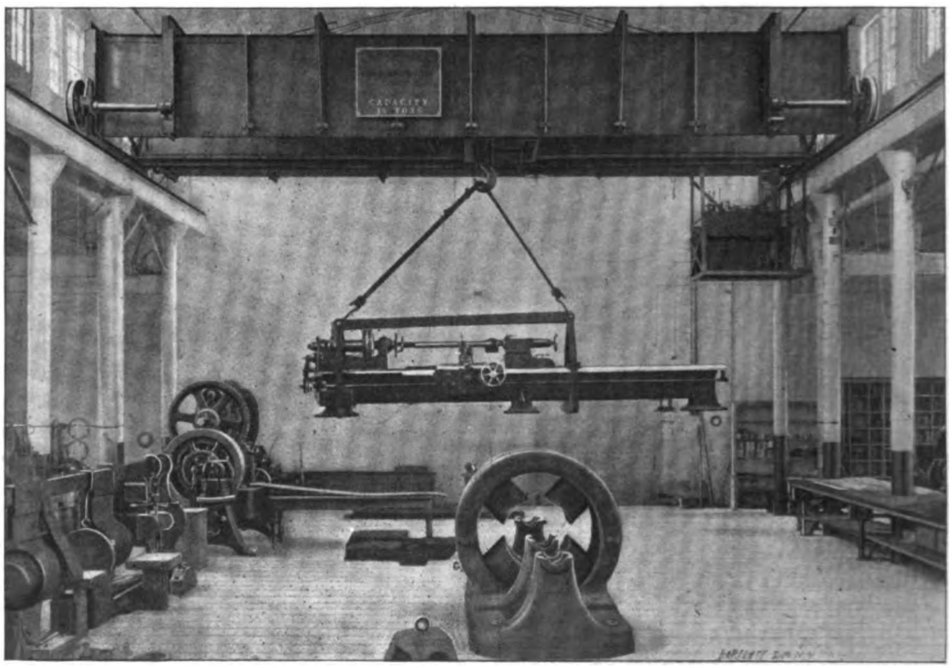

FIG. 18.—ELECTRIC ENGINE LATHE IN OPERATION WHILE SWINGING FROM CRANE.

The ideal condition of electrical power transmission is, of course, that each machine should embody and receive its own motive power. This being done through the co-operation and interchange of plans by motor builder and tool builder, it is at once seen that the cost of mill construction may be lessened, as the heavy strains of shafts and belts at certain points are taken away. Then comes the factor of greater cleanliness and light, while in many trades the absence of the static electricity which has been caused by the friction of belts, etc., is a decided boon. Beyond this, lies the smallness of the power plant necessary, only the exact power needed being taken at each moment, resolving itself into a figure far below that of a factory power plant of the old type. Another point is the ability given at once to utilize water powers within a range of several miles and often in regions where coal and wood are very dear. Yet again comes the point that the power when delivered at the tool is used up under the best conditions. It is said that the chief duty of the machine tool is to remove superflous metal, and that one horse-power will slice off 40 lbs. of cast iron, 33 lbs. of wrought iron, and 23 lbs. of steel. Now, if in almost any fair sized group of shops taken the lost work ranges in the vicinity of an average of 60 per cent., it will be seen that a system which permits the immediate application of the power and an instantaneous stoppage of it, has claims on the score of economy that no manufacturer can ignore. Yet another favorable condition is the fact that the new method permits compactness, which means the requirement of less floor space and less real estate for a given output, and this again brings in the further point that motor driving has everywhere been found to result in smoother operation, with more uniformity in the goods and the ability to secure a better price for the higher quality.

As to the saving in power effected, the diagrams here shown are proof of what can be done. The two upper diagrams are plotted from indicator card readings taken every fifteen minutes during a day's run at the factory of the Central Stamping Company, in Brooklyn. The power required to run the shafting, belting, etc., without tools, was taken in the mornings after the engine had started and before the day's work had begun. At noon and night the same conditions applied. Slightly more power was needed in running in the morning, after the shaft-

ing had been at rest, than at noon when it had been running some time and when the static friction had therefore been

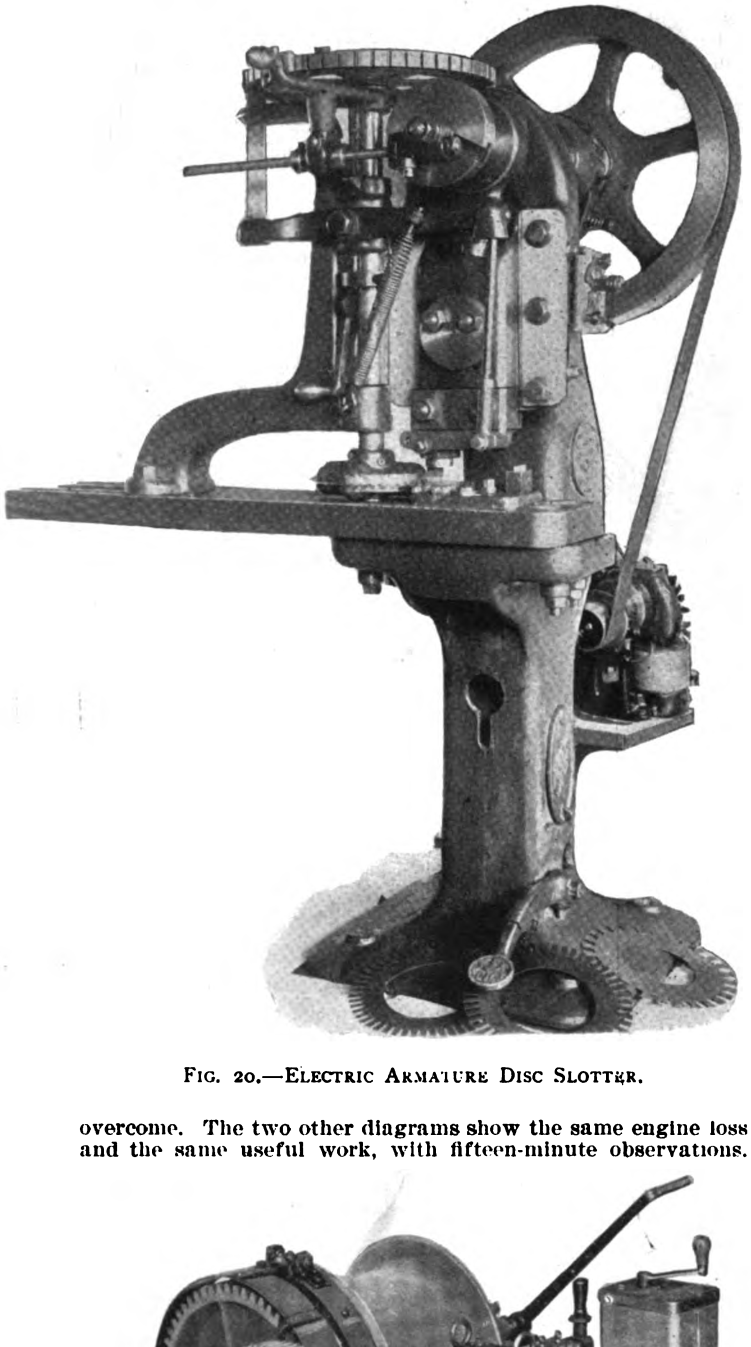

FIG. 20.—ELECTRIC ARMATURE DISC SLOTTER.

overcome. The two other diagrams show the same engine loss and the same useful work, with fifteen-minute observations.

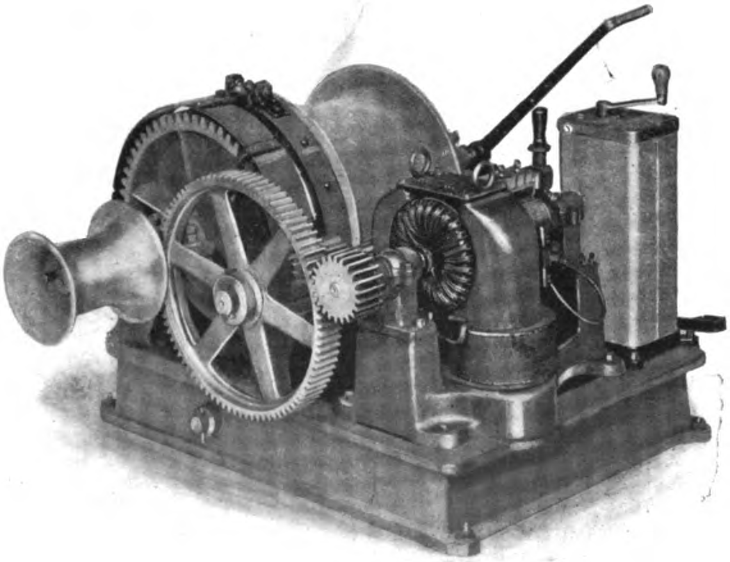

FIG. 21.—ELECTRIC DOCK HOIST.

As an offset to the losses in the friction of shafting are inserted the constant losses which would occur in a dynamo equal to such a plant, as well as those which would occur in motors and in the wires supplying them when delivering the amount of work called for by that part of the diagram included under the designation of "useful work." The assumption of variable losses in the motor and line at 30 per cent. of the useful work is obviously fair and reasonable, and one sees at a glance the relative economy of the two methods, and the saving effected by the electricity.

X.

The works are full of tools and machines that exemplify the belief of the company in their own doctrines and furnish remarkable proof of the manner in which the motor can become an integral part of the mechanism to be driven. A number of the tools are here illustrated, while a few preliminary cuts are shown illustrative of the electrical details of the apparatus.

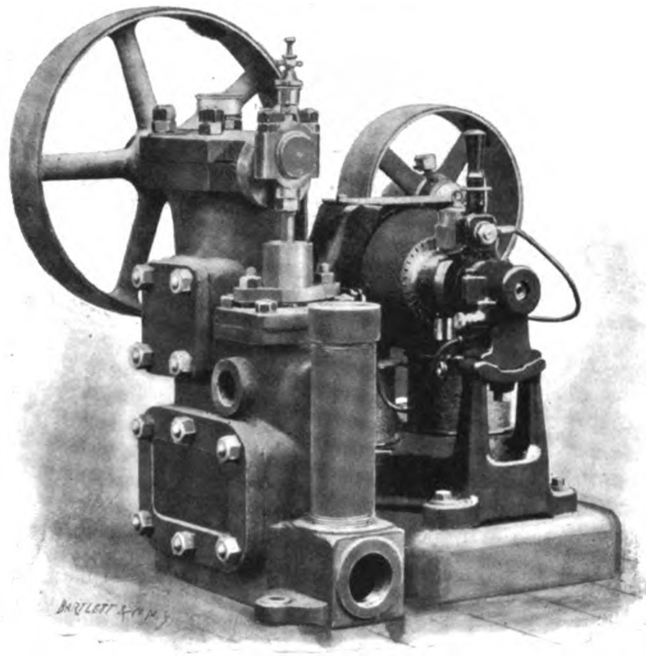

FIG. 22.—BELTED ELECTRIC HOUSE PUMP.

Fig. 5 shows men engaged in winding a 100 kilowatt direct connected armature, and Fig. 6 shows the same complete. Fig. 7 is a view of a 50 kilowatt generator complete direct connected to the engine on the same bedplate. The brushes are supported by a new style of rocker arm, which also carries the current. Consequently the brush studs are metallically connected to the supporting parts, instead of being as usual fitted with insulating bushings that intervene. The brushes are all lifted by a little hand lever at the top. They are controlled by a series of connected links and the links are provided with insulating joints. The adjustment of the point of commutation is made by rotating the rings supported at the extremities of the three stationary brackets reaching out from the field frame, on which they travel on rollers. Figs. 8 and 9 illustrate some of the Crocker-Wheeler direct-connected outfits of four kilowatt and seven kilowatt capacity. Fig. 10 shows their 225 horse-power generator, which output it gives at 400 revolutions. The weight is fifteen tons. Its outboard bearings give firm support to the large pulley. The entire lower half of the machine with the three bearings complete is one piece of iron, giving great rigidity and the steel pole pieces are also cast into the iron.

Fig. 11 is the 100 horse-power machine. Its weight is six tons. The one shown has its brushes arranged for alternating current work. Fig. 12 is the armature core of a 40 horse-power machine before winding and shows the method of clamping the laminae on the shaft. Fig. 13 shows the armature when the "envelopment" is complete. Fig. 14 is an armature of the same size, but with slots for the reception of bar winding. It shows a view of two sets of the bars and the connectors at the end of the armature in position. It is intended for a multipolar two-circuit winding, made under the Bradley patents.

Fig. 15 is a 10 horse-power automatic brake motor with countershaft through the base and changeable gears, giving two speeds to the countershaft. The brake band is attached to one of the field magnets which moves slightly in response to the current and causes the band to grasp the armature or release it, as the current is thrown on or off. Fig. 16 is a 15 horse-power motor with a countershaft through the pedestals, and is

single reduction, intended for mill work. Fig. 17 is a booster consisting of two 100 horse-power machines mounted on a special bedplate. The weight of this massive and useful unit is eleven and a half tons. Fig. 18 gives a view of the crane in the works, to which special reference has already been made.

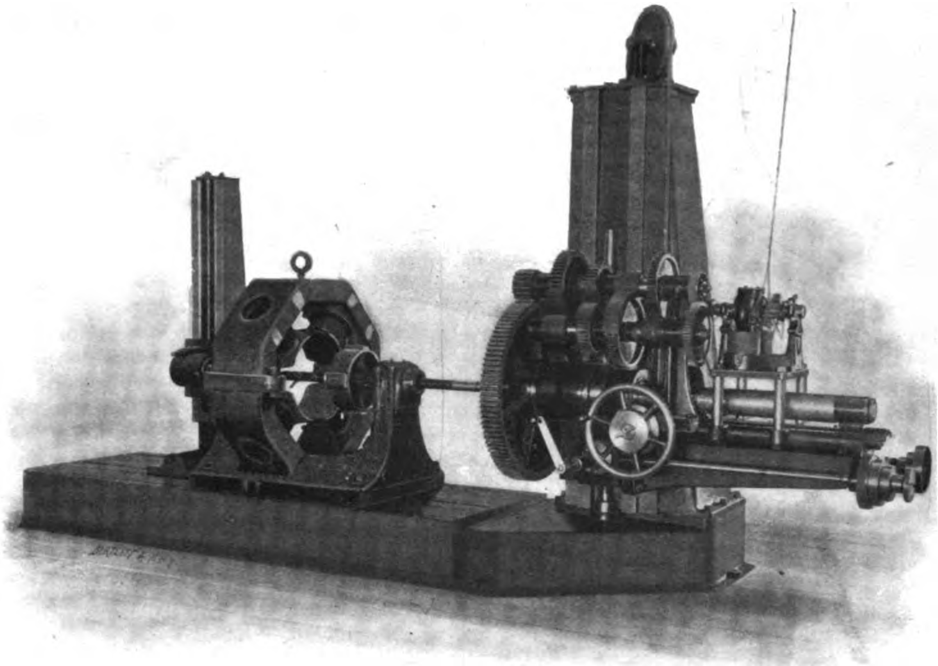

FIG. 19.—MOTOR BUILT ON BORING HEAD, SUPPLYING POWER TO 10-TON BORING MILL.

Fig. 19 is a large boring mill, the weight of which is ten tons. It is driven by a one horse-power motor, the current for which is supplied through an ordinary lamp cord. The adjustments of the machine require the boring head to slide up and down on the column. This necessitated a vertical shaft the height of the housing, with means for keeping it in constant connection with the gearing of the boring head in whatever position the latter might be. The introduction of the motor not only did away with the shaft and bevel gears, but with countershaft and saved all the power that was consumed in operating that transmission in which there was obviously a large amount of friction.

Fig. 20 is a notching press specially designed for the Crocker-Wheeler Company, by the Ferracute Machine Company, to enable them to get out some of their special experimental appliances. It is driven by a one-half horse-power motor directly attached. Fig. 21 is an ordinary electric dock hoist, with the controller mounted on the machine. Fig. 22 is the latest form of Worthington electric house service pump, with a one horse-power motor. Fig. 23 shows a 75 horse-power motor incorporated into a very heavy Worthington steeple pump, such as would run a fair sized city plant.

XI.

We come now to another very interesting batch of Crocker-Wheeler apparatus. Fig. 24 is a Bement & Miles hydraulic press of the pattern usually built for forcing car wheels on axles. In this instance it is specially arranged to be electrically driven, and a capacity of 150 tons pressure is obtainable. Fig. 25 is a Ferracute punch press with motor supported on a bracket on the back in such a position as to gear directly into the teeth cut upon the face of the ordinary fly-wheel of the press. It is a pretty and ingenious rig.

Fig. 26 shows two sizes of controllers or regulators for motors on heavy power work. The contacts are all made of heavy castings and are easily replaceable. Each contact is arranged to be out of the range of the others, so that in case of any trouble, the burning out of one will not interfere with the perfect action of the rest.

Fig. 26 A shows a 1-6 horse-power motor-dynamo for charging storage batteries for telephone exchanges, by current direct from the lighting circuits of the building. The machine is provided with a circuit-breaking device operated by the fields of the machine, so that the battery is automatically disconnected when the machine stops.

Fig. 27 is a universal adjustable boring mill built by the Newark Machine Tool Company for fine work, and fine work it does. This was originally operated by cones and belts, but has been altered by the substitution of a cone of gear wheels in place of the belt pulley, to which a bracket supported motor is geared. The usual changes of speed are therefore obtained by throwing either one or the other of the set of gears in the cone in action.

Fig. 28 is a small punch press with motor mounted on a side bracket and connected by a belt which passes around an "outboard idler." By this arrangement a very large circumference of contact is secured on the motor pulley, enabling the machine to be operated by a smaller motor and pulley than would otherwise be the case. Fig. 29 is a Bridgeport vertical boring mill, which was driven by cone and belt and altered by the Crocker-Wheeler Company after purchase, by adding a cone of gears to which the motor is attached. Changes of speed are obtained by the shafting feather which engages one or other of the gears. Fig. 30 is a novel piece of machinery to find in an electrical works and is a regular silk loom on which a one horse-power motor has been attached. Six of these were set up in operation at the old works, up to the time of the fire, turning out choice samples by which the salesmen of the Ampere Silk Company were enabled to take their fall orders while the mill of the silk company was being built. The driving of looms has always been considered as requiring the highest attainable smoothness in power work.

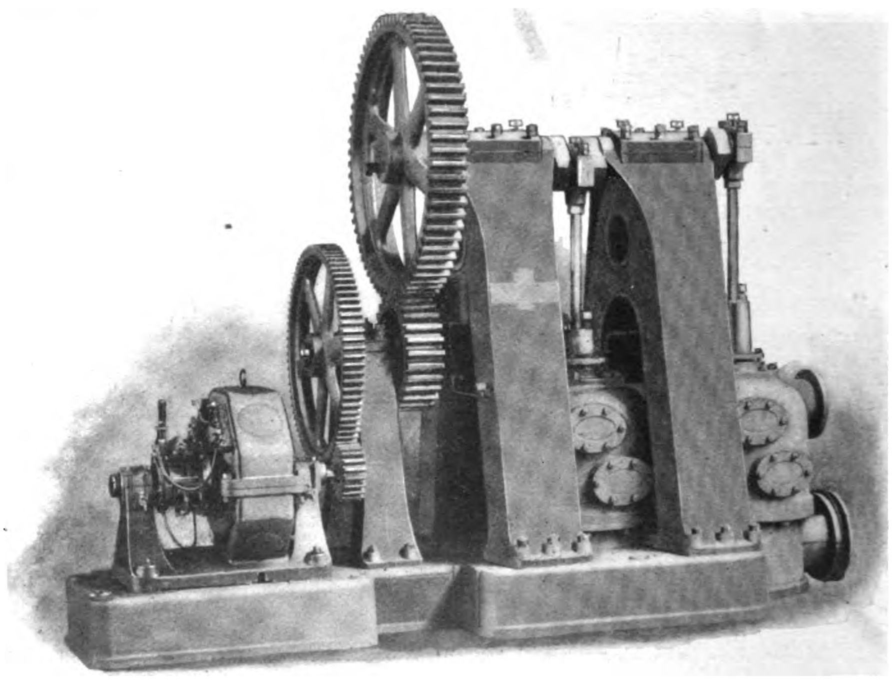

FIG. 23.—MOTOR GEARED TO "STEEPLE" PUMP.

XII.

A high grade of product cannot be obtained without a high grade of men, and from the start it has been the desire of Dr.

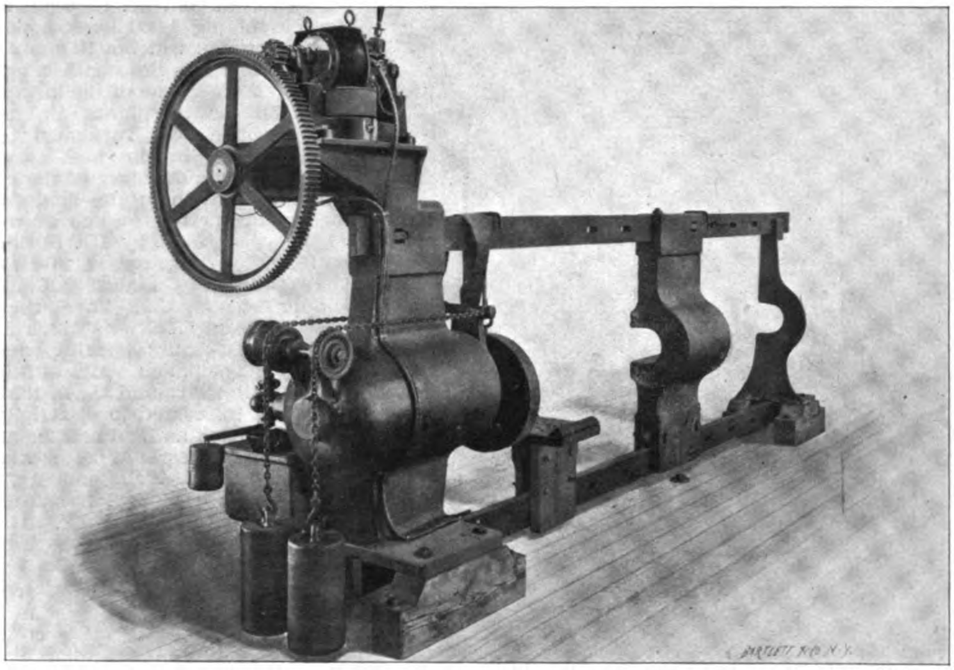

FIG. 24.—ELECTRO HYDRAULIC PRESS, 150 TONS CAPACITY.

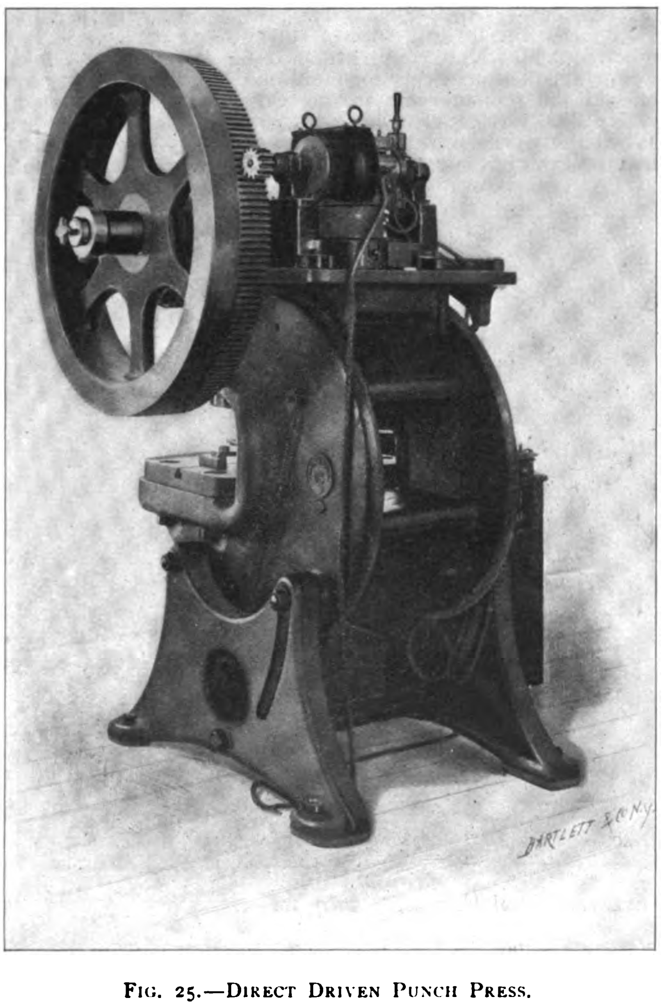

FIG. 25.—DIRECT DRIVEN PUNCH PRESS.

Wheeler and Professor Crocker to surround themselves with a staff of the highest creative and executive ability. It is telling the simple truth to say that in their efforts they have been successful and have gathered around them a corps, each member of which is a picked man and known for his leadership and force. This article would not be complete without brief personal note and biographical data of the men who have carried the Crocker-Wheeler Electric Company to the front rank and who keep it there.

Schuyler Skaats Wheeler, president of the Crocker-Wheeler Company, was born in New York City, in 1860, attended the Friends' Seminary, Keble Hall, Columbia Grammar School and Columbia College. Leaving the college in 1881, Mr. Wheeler became assistant electrician of the Jablochkoff Electric Light Company. When that company dissolved he joined the United States Electric Lighting Company, and subsequently left them to become a member of Mr. Edison's staff. Mr. Wheeler was present at the inauguration of the Pearl street station, was afterwards made the electrician in charge, and was detailed to lay the underground systems in other cities. He then became superintendent of the Newburg (N. Y.) Edison Company, resigning that post to accept the position of electrician to the Herzog Teleseme Company. Mr. Wheeler left the latter company at the time of the organization of the C. & C. Electric Motor Company, which he joined as electrician and factory manager. After establishing the factory of the C. & C. Electric Motor Company, he organized the firm of Crocker & Wheeler, electrical engineers, which was shortly afterwards incorporated as the Crocker-Wheeler

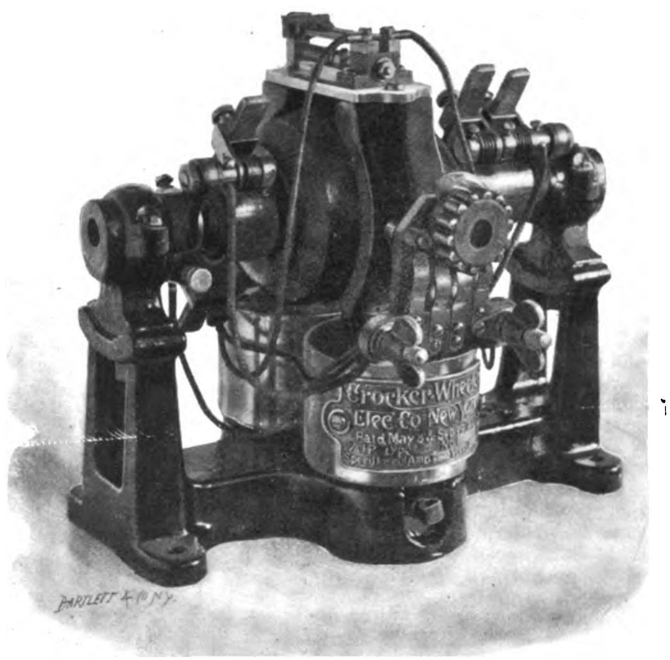

FIG. 26A.—1/6 HORSE-POWER DYNAMOTOR, WITH AUTOMATIC CUT-OFF SWITCH.

Motor Company, of New York State, and afterward the Crocker-Wheeler Electric Company, of New Jersey, of both of which he is the president. He was also appointed electrical expert of the Board of Electrical Control of New York, holding this position about seven years, or from the time of its creation to its abolition, doing much in relation to overhead wires in New York, and becoming very prominent before the public. He is also president of the Bradley Electric Power Com-

pany and a director in the important American Electric Heating Corporation, of Boston.

He is the author of numerous writings on electrical matters, including two illustrated supplements to "Harper's Weekly," in 1888 and 1889, upon "Applications of Electricity," and upon "Electric Lighting," and is joint author with Professor F. B. Crocker, of "The Practical Management of Dynamos and Motors." He has received the honorary degree of Doctor of Science on account of his electrical work and writings during a period of about four years after leaving college. He is a member of the American Society of Civil Engineers, the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the University Club, Chamber of Commerce, the American Yacht Club, the Uptown Association, etc.

Professor Francis Bacon Crocker, vice-president of the company, is a member of an old New York family and a graduate of Columbia College School of Mines. His early work in the motor field has already been referred to. When the question came up of inaugurating special electrical studies at Columbia, he was one of the two or three men hit upon for selection, and the choice that was made has proved to be very happy. The electrical work done at Columbia is of high order and value. Outside his engineering and professional work, Professor Crocker has been a prolific writer, and his new book on the subject of power plants and electric lighting is easily one of the standards. He has also been very active in the work of the American Institute of Electrical Engineers, and is regarded as one of its foremost members and officers, as well as one of its most useful and faithful. He is a member of the University and other Clubs, but confines his energies within well-marked channels of educational and professional activity.

Harvey Lamb Lufkin, manager of the company, is one of the very few whose time has been continuously devoted to the development of the electric power industry from the practical standpoint since the first advent of the commercial electric motor. To Mr. Lufkin's early conceptions of the possibilities of electric power as applied in mills and factories and his persistent industry in enforcing his beliefs, is due in a large degree the growth of this branch. At the time of his association with this company in November, 1892, its product was confined to motors and dynamos of 5 horse-power and under. That a recent contract for a power plant involving 1,000 horse-power of apparatus in which a 100 horse-power motor was the smallest machine, and that some of the largest industrial power plants in the country have been furnished by this company in the past three years, is strong evidence of the remarkable growth of the business during this period. Some of the original work done by Mr. Lufkin in the field of applied electric power embraces almost all the leading events that have their place in history fully as much as the landmarks of lighting and railway development. Mr. Lufkin was born in Cleveland O., in 1857, was early interested in electricity and as far back as 1886 became an associate of Messrs. Wheeler and Crocker in the C. & C. Company.

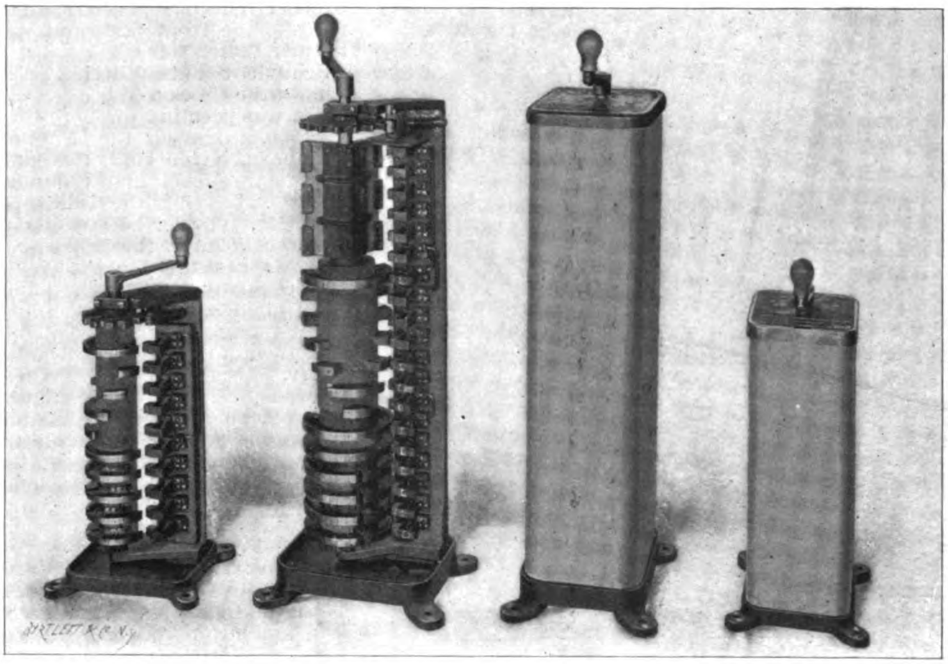

FIG. 26.—REVERSING REGULATORS FOR HEAVY MOTORS.

Frank Moore Jeffery, treasurer, was born in Corning, N. Y. His early life was spent at New Haven, Conn., and Oxford, Md. Removing to Jersey City, N. J., he established a printing business which was transferred to 22 Beekman street and carried on under the firm name of Jeffery & Johnson. He withdrew from the firm to engage in the manufacture of springs and in 1888 he formed a partnership with his brother, D. H. Jeffery, for the manufacture of springs and wire work, large quantities of which were furnished for the Crocker-Wheeler Company. Through this acquaintance, Mr. D. H. Jeffery was offered the treasurership of the Crocker-Wheeler Company, which finally resulted in his withdrawal from the other firm. When the works were removed the Company reorganized under the laws of New Jersey, and F. M. Jeffery became one of the charter members. Since that time he has been its resident director. Shortly after this arrangement was made, Mr. D. H. Jeffery died very suddenly and Mr. F. M. Jeffery was elected secretary and treasurer in his place. Besides attending to the finances, Mr. Jeffery has the general management of the

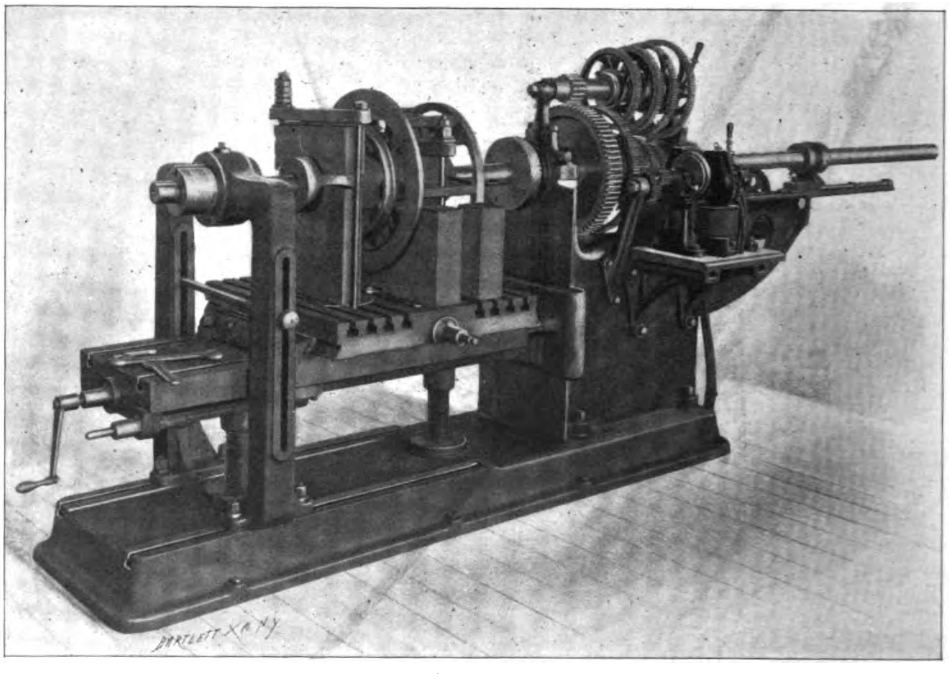

FIG. 27.—ELECTRIC BORING MILL FOR FINE WORK.

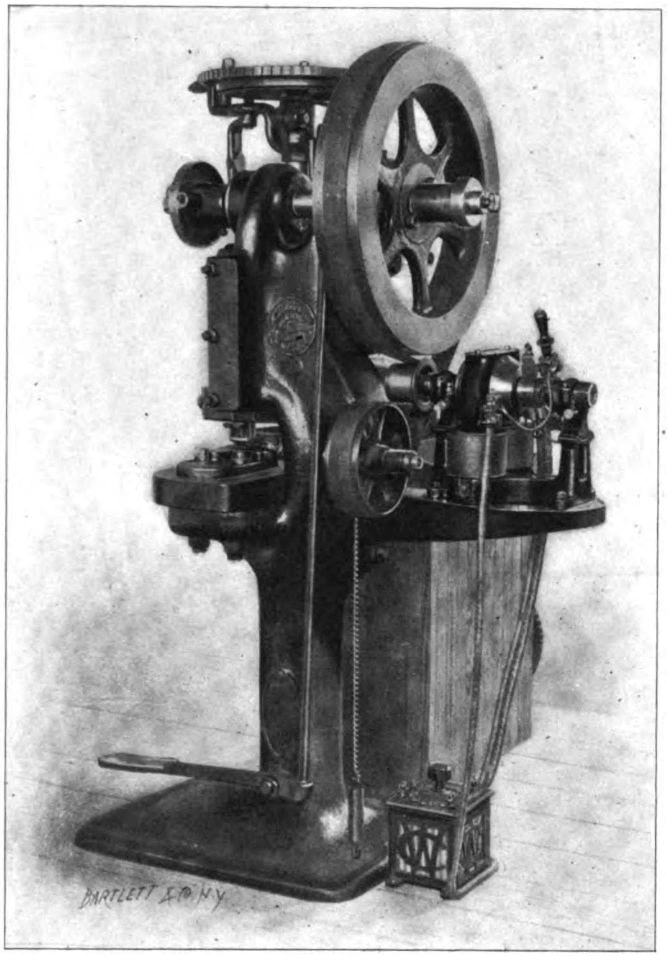

FIG. 28.—ARMATURE NOTCHING PRESS, BELT DRIVEN.

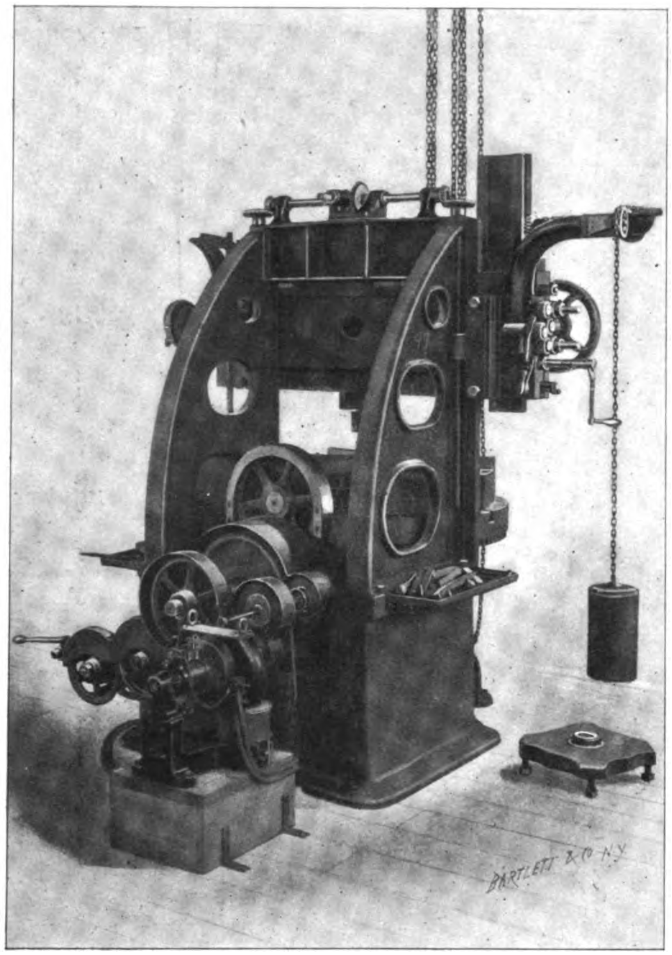

FIG. 29.—VERTICAL BORING MILL, DIRECT GEARED.

works. His thoughtful and systematic attention to production has contributed largely to the success of the company. The treasurer is ably assisted at the New York office by George W. Bower, cashier and general bookkeeper, whose accuracy and faithfulness are unfailing.

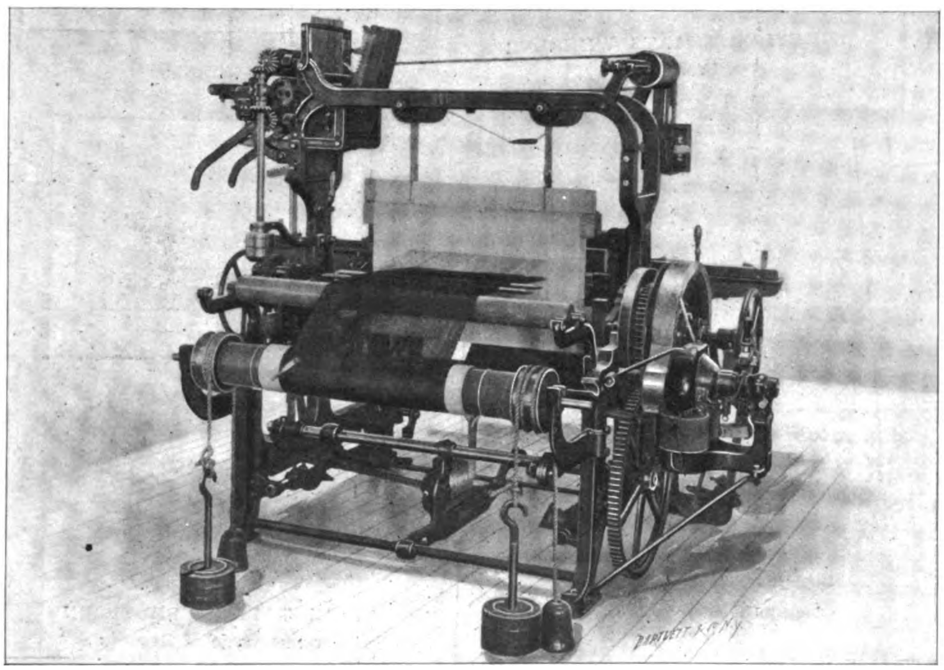

FIG. 30.—ELECTRIC LOOM WEAVING AMPERE FIGURED SILK.

Gano Sillick Dunn, chief engineer of the company, was born in New York and graduated from the City College in 1889 with the degree of Bachelor of Science; thence entering the new post graduate course in Columbia College immediately, from which he graduated in 1891 with the degree of Electrical Engineer. Although on account of reverses Mr. Dunn supported himself entirely by outside work as a telegraph operator during his entire courses at both colleges, he ranked close to the head of his classes and was an honor man and a member of the Phi Beta Kappa.

Immediately after graduation in June, 1891, he went to the Crocker-Wheeler factory for one week for experimental work, with such commendable results that he was never allowed to leave. As electrical engineer and as chief engineer, Mr. Dunn is the responsible head of all the engineering work.

His new designs are models of modern engineering skill as shown by the reputation of Crocker-Wheeler apparatus to which he has also contributed many valuable inventions.

He is a member of the American Institute of Electrical Engineers and vice-president of the New York Electrical Society. Mr. Mr. Dunn's lectures have brought him into considerable prominence, his last lecture on Dynamo and Motor Design having been greatly in demand in pamphlet form.

Miss Belle Jeannette Hamilton, the order clerk, though born in New York, is of Scottish descent on both sides. She entered the service of the company as stenographer in June,

OFFICERS AND STAFF
THE CROCKER-WHEELER ELECTRIC CO.

1890, since which time she has risen to the highest clerical and confidential position in the company. Stationed in the New York office, she has sole charge of the entry of every order on the works. The interpretation of orders and the figuring of many electrical questions, for which she has fitted herself by private study, is done in a way that surprises many engineers, and is of great credit to her. Miss Hamilton acts also as confidential clerk to the directors.

Frederick Malling Pedersen, M. S., E. E., is engineer in charge of specifications and records. Mr. Pedersen is a graduate of the College of the City of New York, and received the degree of Bachelor of Science in 1889, of which class he was valedictorian. He then taught manual training for one year and studied architecture. He received the degrees of Master of Science from the College of the City of New York in 1893 and of Electrical Engineer from Columbia University in the same year. He joined the Crocker-Wheeler Electric Company immediately after the completion of his electrical course. Since then he has delivered frequent lectures before the Pratt Institute, the Young Men's Christian Association, the American Institute and the Henry Club.

August Hartmann, superintendent, was born in Hanover, Germany, in 1849. He received his early education in the gymnasium, and entered Wellenkamp's machine shop at the age of 14, where he served his time. He came to America in 1867, and entered the Singer Co.'s factory in New York City. After remaining there five years he went with the Caligraph Company, and then the Columbia Typewriter Company. In 1886 he entered the employ of the C. & C. Motor Company, in New York, under the management of Dr. Wheeler, and upon the organization of the Crocker-Wheeler Electric Company he left them to take the position of foreman and afterward superintendent of the Crocker-Wheeler Company's factory, which position he has occupied continuously to the present time, covering a period of seven years and extending through their occupancy of the factories in Twenty-eighth street and Fourteenth street, New York, their removal to Ampere and their recent successful struggle to overcome the effects of the fire.

Arthur Lispenard Doremus, a valuable assistant to Mr. Lufkin, in the New York office, is the son of the distinguished scientist and chemist, Dr. R. Ogden Doremus. He was born in New York City in 1869, and attended the College of the City of New York until 1892. Since that time he has been engaged in the service of the Crocker-Wheeler Company.

Henry Chase Ware, factory office manager, was born in Cumberland County, New Jersey, in 1857. His education was received in the public schools. At the age of 21 he entered the employ of the Ferracute Machine Company, of Bridgeton, N. J., in whose service he remained for nine years, as stenographer and bookkeeper. In 1888 he came to New York to take the position of private secretary to the president of the Pittsburg, Shenango and Lake Erie Railroad Company. In the latter part of 1889, he entered the New York office of the Edison Machine Works (afterward consolidated with the General Electric Company, as confidential stenographer and accountant, and for more than four years he was connected with the various branches of the Edison business, a portion of which time was spent at the factory of the Edison Phonograph Works, Orange, N. J., in the capacity of business manager. In the latter part of 1894, Mr. Ware engaged with the Crocker-Wheeler Electric Company, assuming charge of their factory office, time and cost accounts, the purchasing of factory supplies and the correspondence relating to the same.

NEWS AND NOTES.

LORD KELVIN'S JUBILEE.

The celebration of Lord Kelvin's jubilee began at Glasgow on Monday evening, with a conversazione at the Glasgow University. Attendants from many foreign countries were present and the crowds attending the celebration were enormous. Congratulatory telegrams were received from all over the world. Lord Kelvin replied to these by a dispatch sent around the world and returned to the University in four minutes. In New York the event was celebrated by a reception given by the Commercial Cable Company in their offices in the Postal-Telegraph Building. The guests were welcomed by Mr. John W. Mackay and Mr. George Clapperton proposed the health of Lord Kelvin in a very felicitous toast, reciting Lord Kelvin's achievements.

Among those present were Mr. N. Tesla, Professor E. J. Houston, Mr. F. J. Sprague, and other members of the electrical profession and press.

In response to the congratulatory telegrams sent by many of those present, Lord Kelvin replied as follows:

"To my Friends at New York.

"Thank you warmly for your kind sympathy with me on the occasion of the jubilee. I wish I were near enough to shake you every one by the hand and to tell you how much gratified I am that you think of me as a friend and comrade.

"KELVIN.

"Glasgow University, June 15, 1896."

THE TELEPHONE AT THE ST. LOUIS CONVENTION.

At the Republican National Convention, to be held in St. Louis, there is one innovation which will attract attention. In order that the various delegations may at all times be in close touch with the chair, telephonic communication will be provided. Thus, when a delegate in any part of the hall secures the floor, his name is made known to the chairman by means of the telphone, and he will be promptly recognized. In the same manner a delegate may be promptly informed of the question before the house at any time such information is needed. In fact, the telephone may be used in many different ways, and it is believed that it will be found such a great convenience that hereafter the system will be adopted in all great conventions.

A TARGET-SEEKING TORPEDO.

A magnetic attachment has been invented by Mr. C. D. Hawkins, of Boston, the object of which is to draw the torpedo toward the iron armor of a ship against which it is to be projected. In a preliminary test by the Bureau of Ordnance, the wind blew forty miles an hour, and the sea was very rough, but torpedoes fitted with the target-seeking device made more than thirty miles an hour. The government has a contract with the inventor to dispose of the device only to the United States if it proves successful.

JAPANESE ACCURACY.

It is stated that the Japanese are very exact in their tests of goods made under contract, expecting even large pieces of machinery to be mathematically true in every particular. In one instance 450 tons out of 700 tons of galvanized iron telegraph wire imported from Germany were rejected because they had become very slightly oxidized in places when on board ship, and in another again a further quantity of telegraph wire was rejected because its diameter was found to be three-thousandths of an inch too large. This exactitude has its good side, however.

PRIVATE ELECTRIC ELEVATORS IN NEW YORK.

The New York "World" gives a list of about thirty-five private houses in New York City where electric elevators are in use. The names given are those of the leaders of the city's wealthy and fashionable circles, but there is no reason why people of lesser degree should not enjoy the same boon.

TEN THOUSAND DOLLARS is the neat sum that 1,278 employés of the Brooklyn Heights Railroad Company are to have distributed among them as the reward of care and good behavior during the winter.

LETTERS TO THE EDITOR.

MOUNTINGS FOR FLUOROSCOPES.

IN answer to Prof. O'Reilly's good-humored attack on my visual powers, I would assert that I have recently been making a study of optical illusions and I have yet to learn that the dilation of the pupil is able to cause the irregular illumination of the screen referred to; but, granting, for the sake of argument, that the dilation is the cause of the apparent irregularity, then, the eye being at fault, all screens tried at any one time must show the same fault. But such is not the case, therefore the screen and not my sight is at fault.

Since examining the sample the report on which called forth the above argument, I have had opportunity of examining another aluminum fluoroscope of Mr. Le Roy's make and found that it had, unlike the first sample, a uniformly bright screen, but the brightness of its screen was still decidedly inferior to that in Aylsworth & Jackson's instrument.

My tests were made with care and in an entirely disinterested manner, and I can only confirm my first report.

HENRY V. PARSELL, JR.

New York, June 9, 1896.

(With this letter we must close this controversy.—Eds. E. E.)

THE

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CONTENTS.

BROOKLYN TROLLEY ACCIDENTS.

THE City of Brooklyn has had, perhaps, more fatalities than any city where the trolley system has been introduced, but most, if not all, of these accidents previous to that of last week have been due to the carelessness of individuals or the running of cars at too high a speed, but the runaway of the car on the Nassau Electric Railway Company's tracks appears to be among that type of accidents due rather to faulty apparatus and carelessness on the part of the conductor, than the negligence of the motorman. There is probably necessity for more care in running the cars in certain parts of Brooklyn than in almost any other locality, as the tracks from numerous directions converge to several centers where travel is extremely congested. At these points, during certain hours, both pedestrians and motormen can only avoid accidents by the use of extreme caution, and the running over of a number of people at such places is partly explained, and to some extent excused, by the conditions of travel. The accident to which we specially allude, the running away of a car backwards on a down grade, is not of a kind for which it is easy or desirable to find any excuse. From every account which has been published it seems apparent that the motorman was far less to blame than the conductor and the equipment of the car, for which the company is responsible. In the first place, the car was crowded far beyond the limit of safety, and it certainly comes very close to criminal negligence to permit 133 passengers to ride on a car that was built to carry 50 people. When a car is overcrowded in this way it almost always happens that most of the crowd is concentrated near the rear of the car. This takes the weight off the front wheels so that even if they are stopped by the brake it has but a small effect on stopping the car if the grade is considerable.

The use of heavy cars of extra length, which are run at the rate of fifteen miles an hour, or more, at some points of the road, is entirely incompatible with the use of hand brakes of any description, and they are particularly inadequate in the case where heavy grades are to be encountered. Apparently, the company realized this fact as it had adopted the primitive method of stationing two men at the dangerous grade armed with planks to throw under the wheels of runaway cars! What is really needed in this case is a power brake. As a matter of fact, the brakes on trolley cars in general have never kept pace with the requirements of the latter. While the weight and speed of trolley cars are greatly in excess of that of any horse car, the same brakes are frequently used indifferently on both cars, the extra power necessary for the trolley car being supplied by the motorman. On a road where heavy grades occur, emergency brakes of some kind are almost indispensable, and emergency brakes should be applied to the car in such a way that both they and the ordinary hand brakes co-operate independently. This precaution is required in case of the disablement of either one, as was the case in the accident above alluded to.

Another safeguard which should be always held in view by the motorman, especially at dangerous points, is the reversing of the direction of the motors, or rather, as in the present case where the car was running away backwards, running the motors so as to drive the car in a direction opposite to that in which it is going. This last resort was ineffective in this case on account of the slipping of the trolley from the trolley wire. This, of course, was the primary cause of the accident in question, which could have been speedily averted by replacing the trolley; and it appears to have been gross carelessness on the part of the conductor to leave his post at the rear of the car at such a dangerous point of the road. If the trolley had been replaced no accident could have occured even if the brake had been perfectly useless. The importance of having the trolley in proper condition and always in connection with the line cannot be overestimated, and in this respect a large proportion of the trolleys in Brooklyn are decidedly at fault.

Their location under the elevated railroad structure submits them to very hard usage whenever they slip from the line, and many of the cars running on these lines carry trolleys which are badly battered and bent. In the present case complaint had been made about the frequent slipping off of the trolley, but the car was continued in service in spite of this defect. On a level road this would not usually be a source of danger, but on a grade it may easily be the cause of a serious accident as in the present case.

As nearly as can be learned, this accident was due to overcrowding the car, the absence of sufficient braking facilities and the failure to replace the trolley upon the line as soon as it had slipped. The accident cannot therefore be laid to any inherent defect of the trolley system, but entirely to the improper management and equipment of the road and the carelessness of the employés on the car. The lessons taught by it will, it is hoped, not be lost.

STATION SAFETY DEVICES.

ELECTRICAL distribution has called into life numerous auxiliary devices, but though considerable time has lapsed since some of these were first brought out, not all of them have by any means reached a final form, let alone a general standard such as we find in some of the older arts, as, for example, in gas lighting. Take the case of incandescent lamp sockets. The number of types of these still in general use requires manufacturers to keep on hand stocks to meet the demands of their customers, such as cannot probably be found in any other trade of like nature. True, the question has been agitated quite recently looking toward a unification which will bring about a standard form of socket, but the many conflicting interests involved seem to indicate that the day of its adoption is still far in the future.

Another, and in some respects perhaps even more important adjunct to electrical distribution on which difference of opinion still exists to a marked degree, is the question of safety devices. As experience accumulates the impression among electrical engineers becomes stronger and stronger, that the fusible cut-out embodies defects which render it unsuitable for much of the work to which it is now applied, and the result has been that for the more important uses to which a safety device of this nature is requisite, the magnetic cut-out or circuit breaker is alone suitable. This, of course, applies more particularly to central station work and a visit to the most modern power houses shows a marked absence of fuses. But there is one aspect of the question in connection with central station safety appliances which has perhaps not been discussed as fully as it might be, and which involves the startling proposition to remove all safety devices of whatever nature from all lines leading to the outside system of distribution. This proposition will probably be regarded by most central station managers as a rank heresy, but we know of at least one large central station distributing several thousand horse-power, both for lighting and power, in which not a single safety catch is connected to the distributing circuits! In justification of this revolutionary practice we are told that the station management considers it less onerous to run the risk of a burnt out armature than to incur the displeasure of customers by an interruption of the service. This practice has been in force for some time in the station mentioned, and we understand with satisfactory results; the only safety devices there employed being circuit breakers directly included in the dynamo circuits leading to the switchboard—and these are set to break at twice the normal capacity of the machines which they are designed to protect! It seems to us that this practice must at times put a very heavy strain on the system, both outside and inside the station, and practically nullify the advantage for which safety devices are designed. Yet, on the other hand, actual experience in the case mentioned appears to show that no baneful results have ensued from the practice and that indeed the balance seems to be in its favor. Of course, we believe that no one would advocate the slightest relaxation in the employment of protecting devices at the points of consumption of current, but in view of the above practical result, the question arises whether the matter of protection within the station may or may not be overdone in what is now considered best practice. We know that cut-outs constitute one of the bêtes noires of the central station manager, and just what is the limit of their usefulness is one of those matters which still constitute one of the open questions in the art.

A MODEL ELECTRICAL MANUFACTORY.

THE electrical industry has often been characterized as one of mushroom growth, and if this term be confined to the rapidity of its progress no one can find any objection to it. Yet, in spite of the rapidity of its rise, we know of none which stands on a more solid basis of actual work and achievement. Indeed, if the stability of an industry is to be gauged by the manufactories which it has called into existence, then certainly the electrical arts stand well abreast of any on which writers on modern industry are so wont to dwell.

The illustrated description of a modern electrical factory to which we devote extended space in this issue constitutes in itself a strong argument on the stability of the industry. Besides indicating the ability and enterprise of those to whom the creation of such an establishment is due, it exemplifies above all the rapid progress which is being made in the application of electric power to the direct driving of all types of machinery, with the consequent economy in power consumption. Machine tool builders of the more progressive type have long since realized and fallen in line with the inevitable drift towards this method of operation, but there are still many who shrink from undertaking what they consider a too radical step which the change to electricity involves; but it requires no great power of devination to foresee the time when the countershaft and belt in the machine shop or factory will be looked upon as a relic of barbarism. Electric power in machine shops means more than mere saving of coal under the boiler, however. It means more light, greater cleanliness, greater safety to the workmen and all those things that tend towards increased production and better quality of output.

LORD KELVIN'S JUBILEE.

IT is not often given to man to see the fruits of his thought and labor recognized and interwoven in nearly every department of science and industry; but such, indeed, is Lord Kelvin's happy lot. The celebration of the fiftieth anniversary of his professoriate at the Glasgow University is truly an event of universal importance. Whether we look upon his achievements from the scientific or the practical standpoint, everywhere we are confronted with that marvelous perception of the adaptability of natural laws to useful purposes, in which respect he stands without an equal. We join in the congratulations to Lord Kelvin, and in the wish for a long continuance of his life and labors.

CHARGING FOR ELECTRIC CURRENT.

AS was to be expected, the article by Mr. A. J. Farnsworth in a recent issue of The Electrical Engineer has served to call forth a contribution on the same subject in which the author does not entirely agree with Mr. Farnsworth on the practicability of the system of current charges proposed by the latter gentleman. Mr. Lewis seems to view the subject from the consumers' rather than from the central station standpoint and fails to see the commercial justice of asking the consumer to guarantee the fixed charges of the station, whether he does business with it or not. Apropos to the question under discussion is the system of charge adopted at Norwich, England, described on another page. Here the rate of charge between one hour before sunset and 8 p. m. is double that at any other time of the day, the meters being arranged to record in accordance with the rate of charge. We doubt whether a system so widely diverging in its rates could be successfully introduced in this country, but its adoption and evident good working abroad show to what extent consumers can be educated.

EXHIBITION NOTES—VI.

EXHIBIT OF THE ROOT IMPROVED STEAM BOILER.

OUR illustration gives a very good view of the exhibit made by the Abendroth & Root Manufacturing Company, of New York, of their famous improved Root water tube steam boiler, at the recent Electrical Exposition. These boilers were selected to furnish all the steam used at the exposition, the desire being to install a thoroughly reliable and model up-to-date boiler plant. This was the only working boiler plant shown and attracted a great deal of attention and favorable comment from visitors, who could not but be impressed with its cleanliness, efficiency and the ease with which it was managed.

There were two equal units forming one battery of 500 horsepower. A Wilkinson automatic stoker was used to distribute the coal upon the fire. The evaporative efficiency ranged from 10 to 11 lbs. of water per lb. of coal. The C. W. Hunt noiseless conveyor was used in delivering the coal and removing the ashes. So safe and simple was the entire operation of this plant that it was put in charge of Mrs. Frank Walton, a licensed woman engineer, who, as chief engineer, managed the exhibit with rare skill and judgment.

The battery of improved Root boilers used at the Electrical Exposition, we may add, was an exact duplicate of the six batteries of Root boilers used at the celebrated tunnel plant of the Baltimore & Ohio Railroad, in Baltimore, Md.

KEUFFEL & ESSER CO.'S EXHIBIT.

AMONG the exhibits which were not composed of electrical appliances, that of the Keuffel & Esser Company was of special interest. They exhibited their well-known Paragon

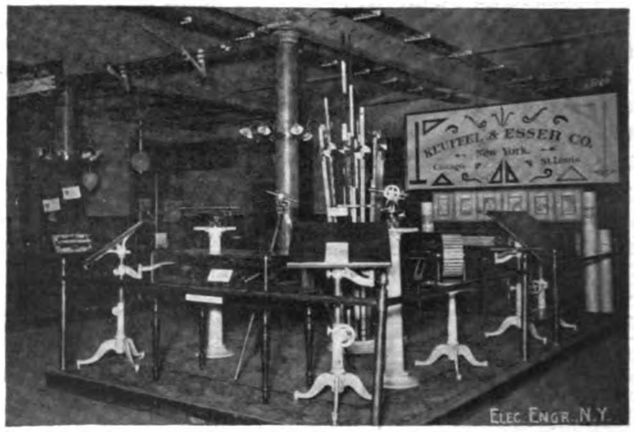
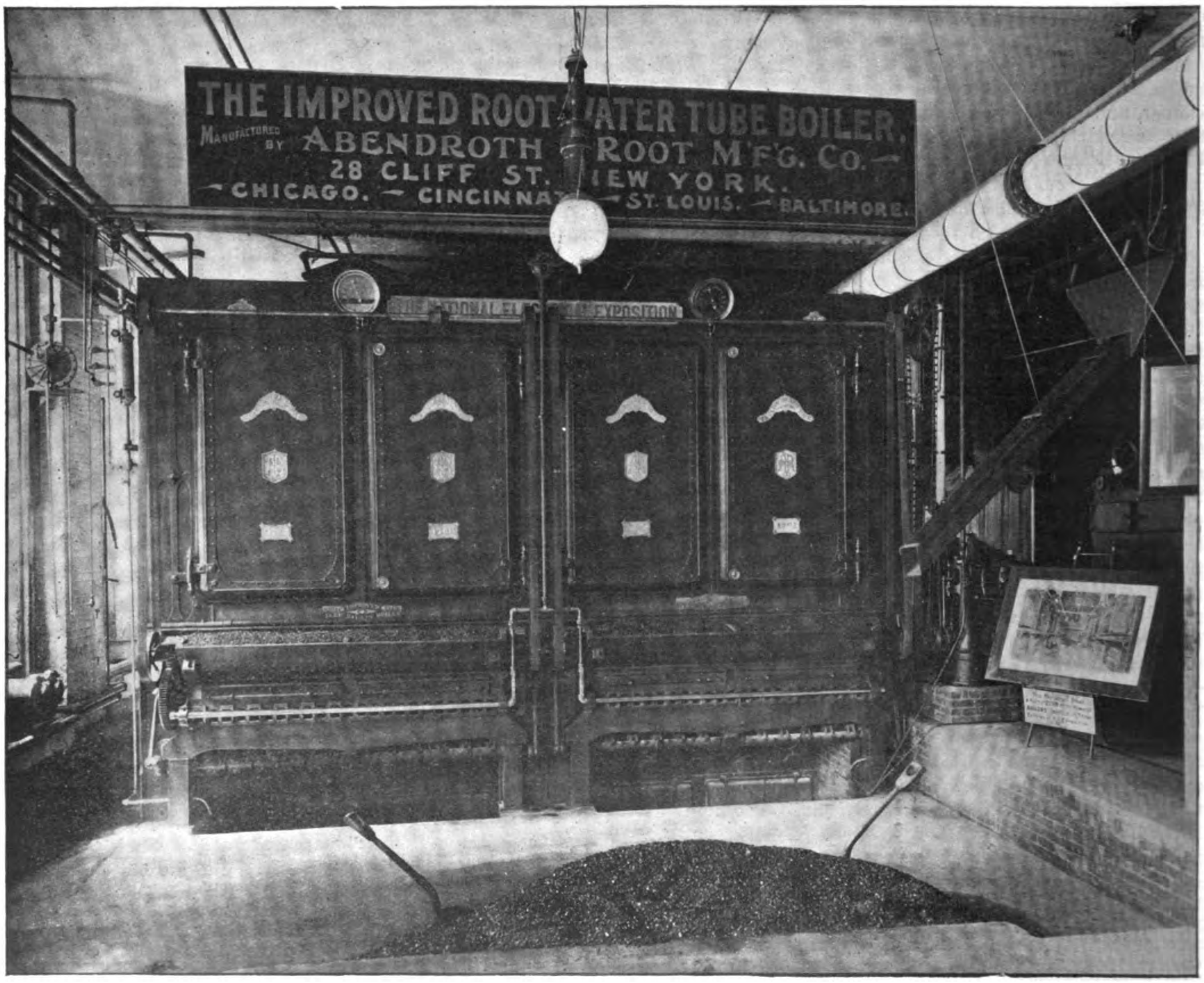


EXHIBIT OF THE KEUFFEL & ESSER CO.

and other drawing instruments, protractors, Mannheim, Duplex, Fuller and Thacher slide rules, reckoning machines, levels, transits, drawing tables, and what is generally comprised under the name of drawing tools. An unusually fine blueprint



BOILER PLANT CONSTITUTING THE EXHIBIT OF THE ABENDROTH & ROOT MFG. CO.

made on their Helios paper was exhibited in a very practical blueprint frame and was a conspicuous part of their exhibit. They also exhibited a heliograph of the pattern adopted by the United States Army. It was labeled "Telegraphing without Electricity," and found many interested examiners. We print in this issue a view of their interesting and well arranged exhibit.

THE IDEAL ELECTRIC CORPORATION.

THE accompanying illustration represents the booth of the Ideal Electric Corporation at the Electrical Exposition. This exhibit included a full line of the well-known La Roche alternators and there were also the focusing lamps of which this company makes a specialty, as well as the Ideal arc lamps. To the right of the illustration is shown a combination individual street fixture and converter which was directly connected across the 1,000 volt main of an alternating circuit. Their alternating arc lamps were distributed through various

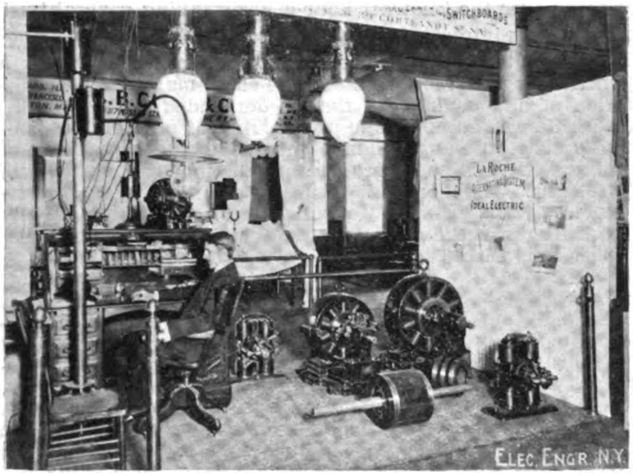


EXHIBIT OF THE IDEAL ELECTRIC CORPORATION.

parts of the building and operated on currents of various frequencies without any change or adjustment.

A prominent feature of the exhibit was a 5 horse-power direct current motor which was self-regulating and could be operated at any speed between 800 and 1,500 revolutions per minute simply by moving the rocker arm about the commutator. The change of speed was accomplished without any sparking at the brushes, and the full horse-power was developed at any speed within the limits of speed mentioned. Other types of direct current machines were also exhibited. The booth was in charge of Mr. F. A. La Roche, the vice-president and general manager of the Ideal Electric Corporation.

OBITUARY.

DEATH OF MR. HARRY J. SMITH.

While inspecting his barn at Washingtonville, near Plainfield, N. J., on Sunday last, Mr. Harry J. Smith, the well-known operating superintendent of the New York Edison Company, slipped from a rafter and fell to the floor, fifteen feet below. Mr. Smith was picked up unconscious and remained in that state for many hours. Examination showed that he had suffered a fracture of the skull and also internal injuries of a serious nature. As we go to press we learn that Mr. Smith expired after a few brief intervals of consciousness. Mr. Smith leaves a widow and three children to whom we extend our most sincere sympathy in their dire affliction.

MARRIED.

MR. EDWARD E. HIGGINS was married to Miss Mary Austin White on June 10, at West Roxbury, Mass. We extend our heartiest congratulations.

ROENTGEN RAYS.

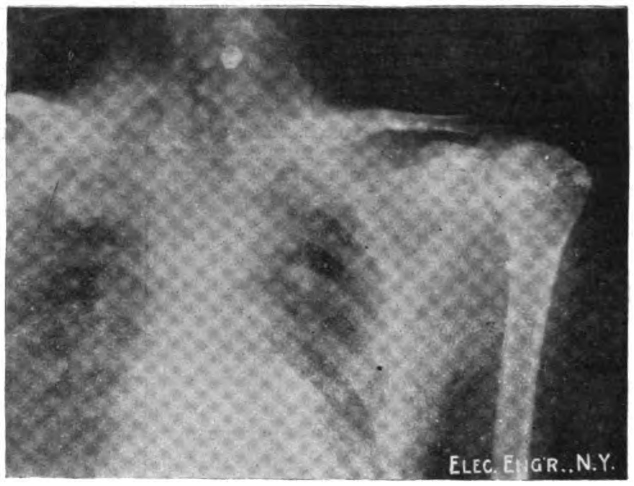
ROENTGEN PICTURE OF CHEST AND SHOULDER.

BY WILLIAM J. MORTON, M. D.

THE picture as here illustrated is a reduction of a 17 x 12 inch negative, converted, in the usual manner, to a positive, in order to show the bones in their natural white color. To a surgeon's eye the acromion and coracoid processes of the shoulder blade are clearly shown in their relations to the head of the humerus, or arm bone, and also the end of the clavicle, or collar bone, is shown in its relations to the shoulder joint. We have, in short, an inner inspection in a living person of this rather complicated joint, the shoulder, and there can be no doubt that in defined pictures of this nature even very slight deformities and diseases would be detected.

It is noticeable that the front portions of the ribs are not shown; only the posterior portions lying nearest to the sensitized plate appear; also the breastbone was sufficiently dense to almost entirely obstruct the X-rays.

A collar button at the back of the neck is taken through the backbone. In some of my negatives the dark outline of the



ROENTGEN RAY PHOTOGRAPH OF CHEST AND SHOULDER OF LIVING MAN. TIME OF EXPOSURE, EIGHT MINUTES, WITH AYLSWORTH & JACKSON FLUORESCENT SCREEN.

heart and liver is shown as well as the outlines of tumors in the brain; but this is evidently for purposes of demonstrating the location of organs, an over-exposure, and does not, therefore, indicate the outlines of the heart. I have also taken an excellent picture of the adult pelvis and thighs.

The question of the fluorescent screen is an important one in advancing the surgical usefulness of the X-ray. I have made many experiments, some of them conflicting in the interpretations which they suggest, but my present opinion is that the screen as made by Messrs. Aylsworth & Jackson makes quick exposures possible and at the same time affords sufficiently accurate definition of the parts. The very slight loss in softness, modulation and sharpness of detail of the negative made without the aid of the fluorescent screen is more than compensated for by the avoidance, when the screen is used, of the weariness of an enforced posture during the longer time.

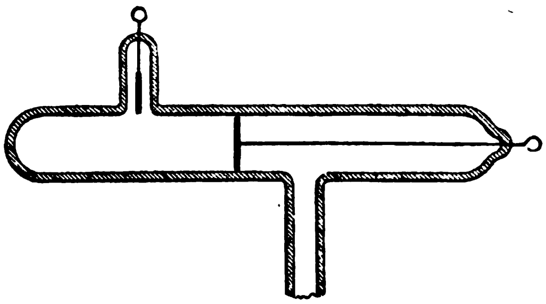
THE X-RAY IN MINING.

Mr. J. W. Scott, a well-known geologist and coal operator, residing at Lloydsville, Cambria County, Pa., claims to be the first to apply the Röntgen process to the discovery of hidden things under the surface of the earth. When the discovery of Röntgen was made public he set about to use it in his work on the Allegheny Mountains, where he is interested in coal developments. The celebrated E vein of coal has for forty years been the object sought after by geologists, prospectors, miners and operators all over the mountain.

Mr. Scott has made some experiments in this direction, the results of which, he claims, will greatly aid the science of locating the mineral deposits of the earth.

COLARDEAU'S X-RAY TUBE.

THE accompanying illustration shows in full size a new form of Crookes tube designed by Mr. E. Colardeau and by means of which very clear photographs have been taken. The tube is cylindrical and of small diameter, and contains a cathode of a diameter almost equal to that of the tube. This is pushed down into the tube to within a short distance of the anode wall. As the small capacity of this tube causes a very



THE COLARDEAU X-RAY TUBE.

rapid alteration of its degree of vacuum owing to the passage of the discharge, it is necessary in order to render it practical to connect to it a communicating vessel sufficiently large which obviates this inconvenience. This small tube is a very powerful source of X-rays. With five minutes' exposure it gave very sharp pictures of objects inclosed in a leather portfolio, using a coil which gave a six-inch spark. The distance of the object from the tube was 15 cm. One minute's exposure gave pictures fairly good, and even one second was sufficient to give feeble but clear pictures of bodies through two sheets of black paper at a distance of 5 cm.

TELEPHONY AND TELEGRAPHY.

MR. KEELYN ON THE DRAWBAUGH PATENTS.

The proposed bill for the issuance of the Drawbaugh patents reported by the Senate Committee has been surrounded by a good deal of mystery. The published statements indicating that there would be another attempt at monopolizing patents on telephones, has, as might have been expected, drawn forth strong protests, among them one from James E. Keelyn, of the Western Telephone Construction Company, Chicago, Mr. Keelyn asserts that he will use every legitimate means and all his energy to prevent favorable action by the United States Senate upon what he calls "another outrageous patent iniquity." Mr. Keelyn asserts that the Drawbaugh applications are owned by a syndicate and that this syndicate proposes to sell to or arrange with the Bell Company to operate these patents if granted.

Mr. Keelyn says that the Drawbaugh claims have been rejected by the Patent Office proper, upon the ground of previous public use, and that there has been another shrewdly operated plan to force the issue of these patents against the advice of the Patent Examiners, and that failing, to lobby Congress to do what otherwise could not be done. It is further claimed by Mr. Keelyn that the present Government suit against the Bell patents would be a simple farce in view of the expiration of the patents, if it were not for the serious fact that the purpose of these suits by arrangement of the Bell Company could be of the most dangerous character. These suits by the Government allege that the Drawbaugh patents anticipated the Bell patents. Now if the Courts hold this to be the case, the Bell patents would have no effect as anticipated, provided Congress should pass favorably upon the issuance of the Drawbaugh patents.

"Briefly," says Mr. Keelyn, "the Supreme Court will hear the matter on October 19. Even if the Supreme Court does not pass adversely upon the patents, there is no question whatever that they could not be made to stop the use of high grade telephones as efficient as the Bell Company's. Therefore the Bell people are trying in another way to regain their weakened hold upon the telephone business. They feel that their efforts at intimidation and bringing patent suits have failed, and they find that their resort to cutting rates in order to stifle competition have also failed.

"It is of the highest importance that these Drawbaugh claims be stamped out before they get life enough to be used to intimidate the public, which seems is their only purpose, as the Drawbaugh apparatus would be worthless in practice at the present date."

MISCELLANEOUS.

CHARGING FOR ELECTRIC CURRENT.

BY WARREN B. LEWIS.

THE article on "Charging for Electric Light Service," by Mr. Farnsworth, in The Electrical Engineer of June 3. cannot fail to be of interest to those concerned in the production and sale of the electric current as a commodity. The article most ably presents a scheme of charging that is certainly desirable from at least the point of view of the central station manager and to be heartily indorsed by the stockholders; but the writer of this communication begs to differ as to the improvement over the kilowatt hour charge, taking general business principals into consideration.

The distribution of the electric current is entered into by a corporation or individual in much the same manner as the distribution of any commodity that is demanded by the public, and with the same knowledge presumably of possible profit or loss. To distribute any commodity requires the investment of capital and there is no assurance that the money invested will yield returns. The merchant has fixed expenses which are independent of the demand for his goods, but which are included in the price he gets; and his experience in his business furnishes him with the information which will enable him to make such a charge as will yield a profit. The electric current is a commodity, the sale of which is undertaken by a corporation or individual, who supposedly knows the chances of profit and loss and the expenses of selling. The fixed charges are no more entitled to be guaranteed by the customers than those of a dry goods house. If the demand fluctuates, as it does in every commodity, or if the customer leaves to patronize another concern, there is no reason why he should pay for the privilege of having the right to purchase if he chooses; for the distributing company exists to solicit trade, not to require a bonus for allowing individuals to buy.

Mr. Farnsworth's idea is a good one if the electric light company is made a mutual or co-operative one, in which each user becomes a directly interested stockholder, the magnitude of his patronage determining his responsibility and entitling him to a yearly return of his share of the undivided profits. In such a plan each customer guarantees the fixed expenses in proportion to his patronage and pays equally for the commodity. He is entitled to a yearly statement and a dividend if there is a profit. But to guarantee fixed charges, pay for the commodity and see the promoter pocket the profits, is very much like "heads I win, tails you lose."

The basis of charging for any article of commerce is a certain price per unit, and the electric current does not differ in its distribution from anything else. It is a misfortune that the production and demand takes place under circumstances that make the business one of hazard with small profit; but that is due to fault of manufacture if the term may be applied. rather than to the fault of manner of selling. The kilowatt hour is a unit that is as perfect in its application as a measure as the quart, pound or yard. In consideration of the purchase of a large quantity, or of quick payment, a discount is allowed; but if the discount is not uniform to all, or if the measure is inaccurate, the fault lies in the merchant, not in the system. The electric current, to be a profitable commodity at lower cost than at present, must be more uniformly produced for consecutive hours. No one appreciates that more than the writer; and a practical method of producing current for ten hours steadily, to be distributed as it is demanded, would be hailed with enthusiasm. But the burden of the present method belongs to the station manager, and his experience and undivided attention will determine a proper kilowatt hour charge in order to do a profitable business.

Until electric current is sold on the co-operative plan the investor must trust to careful management to find a profit in the business, taking equal chances with other investors. There is more room for profit in reorganizing plants that could not make money at 50 cents a kilowatt hour, and producing current at a minimum cost, than in getting the customers to guarantee fixed charges with no assurance that the kilowatt hour charge is going to be any less, or that he is to profit by a method of charging that would induce every capitalist in the country to build an electric light plant.

To make such a plan as Mr. Farnsworth's equitable and fair

to the customers, frequent statements showing the proportion of fixed charge for each one would have to be made and a fluctuation in the number of customers would entail a corresponding change of rate. Numerous accounts with each one would have to be kept to determine whether he was profitable or not. On the kilowatt hour basis, the station manager should certainly know what a kilowatt hour costs delivered, and there is not much room for doubt as to the desirability of retaining each customer.

All business is dull at times. The lighting business is no exception and the most rigid economy must be practiced, without lowering the standard, to pay expenses; but the expense of producing one unit belongs wholly to the producer, and the results will be directly proportional to his appreciation of that fact and his ability and experience.

SOCIETY AND CLUB NOTES.

NORTHWESTERN ELECTRICAL ASSOCIATION CONVENTION.

The fourth semi-annual convention of this association will be held at Marinette, Wis., commencing at 9 a. m., on Wednesday, July 15 next. Papers on "Insurance," "Incandescent Lamps," "Rights of Electrical Companies," "Lightning Arresters," "Alternating Current Motors," "Storage Batteries," "The New York Convention and Exposition," and other subjects, will be presented and discussed. The Entertainment Committee's programme includes picnics, bathing and boating parties, log-rolling frolics, bay excursions, trolley parties, banquet, etc. Hotel rates have been arranged at $2 and $2.50 per day. Indications point to a large attendance, and rooms should be secured in advance. Address H. C. Higgins, Marinette, Wis. The Western Passenger Association has granted a one and one-third fare on the certificate plan from all points in its territory to Marinette and return, one hundred certificates being necessary to secure this rate.

Special through cars for members and their friends will be attached to the Chicago and Northwestern fast train leaving Chicago at 3 p. m. on Tuesday, July 14; Waukegan, 3:50; Kenosha, 4:08; Racine, 4:22; Milwaukee, 5; Oshkosh, 7:15; Neenah, 7:37; Appleton, 7:47; Kaukauna, 8:02; DePere, 8:29; Green Bay, 8:50; Oconto, 9:43, and arriving at Marinette at 10:20 p. m.

Intending attendants are requested to communicate with Mr. Thos. R. Mercein, secretary, at Milwaukee, Wis.

THE CANADIAN ELECTRICAL ASSOCIATION.

THE sixth annual convention of the Canadian Electrical Association will be held in Toronto, Canada, June 17 to 19, 1896. The headquarters of the convention will be in the council chamber of the Board of Trade.

The following papers will be presented:

"Ocean Cables" (Historical), by Chas. P. Dwight, Toronto; "Acetylene Gas" (with demonstrations), by Geo. Black, Hamilton; "Meters," by James Milne, Toronto; "Consideration and Discussion of the Government Electric Light Inspection Act;" "Some Central Station Economics," by P. G. Gossler, Montreal; "Power Transmission by Polyphase E. M. F.'s," by Geo. White Fraser, Toronto; "Operating Engines without a Natural Supply of Condensing Water," by E. J. Phillip, Toronto; "The Outlook for the Electric Railway," by F. C. Armstrong, Toronto.

The social features include a lecture by Mr. James Milne, showing demonstrations of Röntgen rays, and several excursions to nearby points of interest.

REPORTS OF COMPANIES.

CHICAGO EDISON CO.'S ANNUAL MEETING.

THE annual meeting of the stockholders of the Chicago Edison Company was held June 8. President Insull submitted the yearly report. He prefaced the statement by noting that the company had from April to October, 1895, increased net earnings available for dividends 8 per cent. over the net earnings of the same period the previous year. From October, 1895, to April, 1896, the increase was 25 per cent. over the same time of the previous year, making the average increase for the year a little over 22 per cent., rendering net earnings available for dividends about 8¼ per cent. for the twelve months.

For the last two months (April and May) earnings show a generous improvement—in fact, about 9 per cent. has been earned. Mr. Insull then explained the contemplated bond issue. There will mature between now and next January $2,500,000 six per cent. bonds. There is also a floating debt amounting to $300,000. It was the intention of the directors to remove these obligations by issuing $3,500,000 bonds, using the balance (about $700,000) for extension. The president said the remainder of the proposed issue, $2,500,000, would probably not be made for some time—not this or next year—but it was deemed advisable to make the amount sufficiently large to meet all exigencies for years to come. If bonds were placed for the sum actually required ($3,500,000) later, when more money became essential, it would be necessary to obtain it on second mortgage bonds, since the present issue is a first mortgage. The stockholders thereupon sanctioned the issue. By exchanging the different 6 per cent. obligations for the new 5 per cent. bonds the company saves $25,000 per annum in interest.

The following directors were elected: Edward L. Brewster, R. C. Clowry, J. W. Doane, F. S. Gorton, Samuel Insull, R. T. Lincoln, Joseph Leiter, J. J. Mitchell, E. M. Phelps, Byron L. Smith, A. F. Seeberger, A. A. Sprague, Lambert Tree.

WESTINGHOUSE CO.'S STOCK INCREASED.

A special meeting of the stockholders of the Westinghouse Electric and Manufacturing Company was held on June 5, at which it was voted to increase the capital stock from $10,000,000 to $15,000,000. About 140,000 shares were represented at the meeting, which voted unanimously for the increase.

Announcement was also made by the directors of the discontinuance of about 300 patent suits under the agreement entered into with the General Electric Company.

THE NEW YORK EDISON CO.'S EARNINGS FOR MAY.

The Edison Electric Illuminating Company, of New York, report the following earnings for May:

	1896.	1895.	Increase.
Gross	$169,166.57	$155,858.51	$13,308.06
Net	77,751.92	75,146.35	2,605.57
Gross, 5 months	$946,836.62	$868,310.79	$78,525.83
Net, 5 months	477,120.60	417,728.60	59,392.00

LEGAL NOTES.

GENERAL ELECTRIC CO.'S SUITS ON THE UNDERRUNNING TROLLEY PATENT.

Suit has been brought in the United States Circuit Court by the General Electric Company against the Nassau Electric Railroad Company, of Brooklyn, for infringement of the Vandepoele patent, No. 495,443, of April 11, 1893, covering the underrunning trolley. The order issued by Judge Lacombe enjoins the Nassau Company from adding to its present equipment pending the hearing of the question of injunction which has been set for June 26.

The suit brought by the General Electric Company against the New York, Elmsford and White Plains Railway Company was professedly to enjoin the use of four trolleys used by that road. The real object was to compel that railway to buy its entire electrical equipment of the General Electric Company, throwing out the present Walker equipment of motors, trolleys, etc. The Walker Manufacturing Company was sued with the New York, Elmsford and White Plains Company, but took the position that it had not been properly served, and was therefore not in court. The court declined to issue an injunction against the Walker Company, declined to issue any injunction against the four trolleys referred to, but enjoined the New York, Elmsford and White Plains Company from further infringement.

ST. LOUIS UNDERGROUND WIRE ORDINANCE DECLARED VOID.

The Supreme Court, sitting en banc, holds, in the case of the St. Louis Underground Service Company against the street commissioner of St. Louis, that all city ordinances granting corporations the right to lay conduits and subways for electric wires and other similar uses, are void. The city holds the streets in trust and cannot grant their use for private purposes. This opinion is of great importance in view of the proposed subway system now contemplated by St. Louis.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS ISSUED, JUNE 9, 1896.

Batteries:

AUTOMATIC ELECTRICAL BATTERY CUT-OUT. H. W. Clelland and F. J. Madden, Wilkinsburg, Pa., 561,565. Filed Dec. 11, 1895.

A float rod and means for making contact thereby when liquid in jars reaches a certain depth.

ELECTRIC BATTERY ELEMENT. G. J. Ortner, Pueblo, Colo., 561,810. Filed Feb. 18, 1896.

A zinc element for a battery, comprising a hub portion having a tapered opening, and an amalgamated zinc supporting stem having a tapered portion at its lower end.

GALVANIC BATTERY. T. E. Fogalsang, Sacramento, Cal., 561,878. Filed July 29, 1895.

Consists of an acid electrolyte mixed with a solution of eucalyptus.

Storage Batteries:

ELECTRICAL ACCUMULATOR. Gaston de Schrynmakers de Normael, Brussels, Belgium, 561,872. Filed May 1, 1895.

Negative material therein, and the depolarizing peroxide arranged in direct contact with the negative material.

Conductors, Conduits, and Insulators:—

ELECTRICAL CONNECTION. T. Grutting, St. Paul, Minn., 561,951. Filed Aug. 19, 1892.

A base or receptacle having an annular groove with gates, a contact ring therein, and the connecting screw secured in the center, and provided with an annular rib or guard.

Distribution:—

SYSTEM OF ELECTRICAL DISTRIBUTION. C. P. Steinmetz, Lynn, Mass., 561,735. Filed Jan. 6, 1894.

The combination of an alternating current generator, of armature conductors arranged in sections angularly displaced in such manner that such sections tend individually to generate currents substantially 60 degrees apart in phase, with means for converting such displaced currents into a three-phase current system.

Dynamos and Motors:—

ARMATURE FOR DYNAMO ELECTRIC MACHINES. F. D. Ide, Eau Claire, Wis., 561,590. Filed April 14, 1896.

The combination of a core with armature coils disposed thereon, and U-shaped retaining links adapted to secure said coils in position.

DYNAMO ELECTRIC GENERATOR. B. G. Lamme, Pittsburg, Pa., 561,593. Filed Sept. 4, 1895.

Two commutators and two sets of armature coils arranged in pairs, the pairs of each set being at right angles to each other, and the two sets being connected in series through the commutators.

FORM FOR WINDING ARMATURE COILS. J. A. Webber, Lynn, Mass., 561,636. Filed Jan. 25, 1896.

Comprises a suitable base, means for confining the coil, and a series of terraces or grooves upon which one part of the coil is wound.

THERMO-ELECTRIC GENERATOR. H. B. Cox, Hartford, Conn., 561,657. Filed Feb. 13, 1895.

Comprises a supporting casing forming a water jacket, and the removable active element forming the inner wall of the water space and removable from the casing without disturbing the same.

ELECTRIC MOTOR. W. H. Cooley, Brockport, N. Y., 561,699. Filed March 12, 1895.

In combination with the armature and field in an alternating current machine, rectifying devices carried by such armature or field and co-operating with others carried by a third element, and means for establishing and maintaining a relative synchronous rotation between such third element and the armature or field carrying such rectifying devices.

ELECTRIC MOTOR. W. H. Cooley, Brockport, N. Y., 561,700. Filed March 12, 1895.

Two magnetically separate series of field magnets, mechanically united and each energized by alternating currents of different phase and two magnetically separate armatures located in operative relation to such magnets.

DYNAMO ELECTRIC MACHINERY. F. G. Mayer, Chicago, Ill., 561,803. Filed Oct. 18, 1895.

An outer casing and a core concentric therewith, an armature consisting of a core adapted to revolve between said outer casing and said concentric core and having a series of concentric metallic cylinders mounted thereon, said cylinders being insulated from each other and from said core.

ELECTRIC MOTOR AND MOTOR GENERATOR. W. H. Cooley, Brockport, N. Y., 561,867. Filed May 21, 1895.

Consists in the combination, with the elements of a rotatory transformer, of means for producing in one of such elements a rotatively progressing series of fields opposed to a third element to which it bears the relation of armature or field.

CONTINUOUS-CURRENT RECTILINEAR MOTOR. P. W. Leffler, Chicago, Ill., 561,899. Filed Oct. 8, 1895.

Means whereby a continuous current may be supplied to an electromagnetic element carried upon a vehicle to produce shifting magnetic poles adapted to react upon fixed poles situated along the line of travel of the vehicle, whereby the vehicle is propelled forward.

Lamps and Appurtenances:—

ELECTRIC ARC LAMP. S. Bergmann, New York, 561,560. Filed Feb. 27, 1895.

Relates to the feed mechanism.

Measurement:—

ELECTRIC METER. R. O. Hood, Danvers, Mass., 561,711. Filed Jan. 26, 1895.

The revolutions of an electric motor are registered to give an indication of the consumption of electricity.

ELECTRICAL MEASURING INSTRUMENT. H. A. Rowland, Baltimore, Md., 561,918. Filed Oct. 2, 1895.

The combination with a dynamometer, of a shunt box connected to the terminals of the dynamometer, and a pivoted arm making frictional contact with the base of the instrument and carrying a reading scale.

ELECTRICAL MEASURING INSTRUMENT. H. A. Rowland, Baltimore, Md., 561,919. Filed Oct. 2, 1895.

A wall instrument furnished with a telescope and scale or lamp and scale hinged to it and capable of being folded against the wall when not in use.

ELECTRIC SELF-WINDING CLOCK. R. A. Mitchell, Brooklyn, N. Y., 561,943. Filed Jan. 16, 1895.

Employs a single line wire.

Miscellaneous:—

ELECTRICAL APPARATUS FOR CONTROLLING MOTION OF CRANES, ETC. J. A. Essberger and A. W. Geyer, Berlin, Germany, 561,777. Filed Sept. 29, 1894.

Means whereby a single lever is employed.

ELECTRIC ELEVATOR. H. R. Smith, Chicago, Ill., 561,828. Filed March 16, 1896.

A hoisting motor, comprising a solenoid having a stationary core, and a movable coil, said coil connected to the car hoisting cable.

ELECTRIC CHIME. J. H. Gerry and F. M. Schmidt, Brooklyn, N. Y., 561,881. Filed March 18, 1895.

Railways and Appliances:—

RAIL BOND. L. Cook, Worcester, Mass., 561,698. Filed April 11, 1896.

Consists of an inner soft metal split sleeve, having a central hole to receive the wire and an outer split hard metal sleeve having a cylindrical outer surface with a tapered end.

ELECTRIC RAILWAY. W. M. Schlesinger, Philadelphia, Pa., 561,821. Filed Aug. 4, 1895.

A conduit system employing traveling connections and means for lighting the cars with independent current.

ELECTRIC RAILWAY. C. E. Stanley, Gallipolis, O., 561,830. Filed Sept. 27, 1895.

The conductor is laid in a narrow groove in the web of one of the rails and connection is made through the wheel.

ARC INTERRUPTER FOR STREET CAR CONTROLLERS. G. Valley, Cleveland, O., 561,838. Filed Feb. 10, 1896.

Comprises an electromagnet internal to the drum and having projections from its pole pieces extending through the drum in proximity to the contact pieces thereof.

REVERSING AND CUT-OUT SWITCH USED IN ELECTRIC STREET CARS, ETC. G. Valley, Cleveland, O., 561,839 Filed Feb. 26, 1896.

Provides a switch by which the reversing of the motors as well as the cutting-out of either motor, may be effected by a single switch, and the usual separate reversing switch and separate cut-outs may be dispensed with.

ELECTRIC RAILWAY. P. W. Leffler, Chicago, Ill., 561,898. Filed Aug 12, 1895.

Details of construction.

Regulations:

AUTOMATIC MOTOR STOP. W. M. Wood and J. C. Miller, Elmira, N. Y., 561,846. Filed Oct. 21, 1895.

Comprises a governor, trip mechanism in position to be struck when the governor is actuated by undue speed in the motor, and an electric circuit closer retained by the trip mechanism, and a stop mechanism controlled by the electric circuit.

AUTOMATIC MOTOR STOP. W. M. Wood and J. C. Miller, Elmira, N. Y., 561,847. Filed Oct. 21, 1895.

A rod acted upon by a weight thrown out by centrifugal force, and one end of said rod being adapted to strike the terminals of an electric circuit.

Switches, Cut-Outs etc:—

ELECTRIC SWITCH. M. Guett, Hartford, Conn., 561,581. Filed Nov. 29, 1895.

A pivoted arm connected by a spring to a hand controlled pivoted lever.

ELECTRIC SWITCH. J. L. Hornig, St. Louis, Mo., 561,588. Filed Aug. 26, 1895.

Comprises a spring actuated disc of insulating material, a conductor plate arranged in said disc in such a manner that its ends appear on the periphery, two contacts which co-operate with said conductor plate and suitable mechanism for tripping said disc.

Telegraphs:—

TELEGRAPH RELAY. E. Butler, New York, 561,653. Filed June 15, 1893.

Consists of a pair of electromagnet coils, provided with an armature opposed to both cores and a stationary solenoid surrounding the shaft of said armature.

Telephones:—

REGISTER FOR TELEPHONES. E. L. Morey, Portland, Ore., 561,601. Filed Aug. 13, 1895.

Comprises a fork for engaging with the receiver and means for actuating indicating mechanism.

TOLL COUNTER FOR TELEPHONE LINES. G. P. Seligmann-Lui, Paris, France, 561,619. Filed Aug. 18, 1894.

Comprises apparatus at the central station for normally preventing the passage of telephonic currents over said line, a circuit controlling device at the terminal station for operating said apparatus at the central station to thereby permit the passage of telephonic currents and a recording instrument at the terminal station, operated by said circuit controlling device.

CIVIL SERVICE EXAMINATION FOR ELECTRICAL EXPERT TO THE N. Y. STATE RAILROAD COMMISSION.

A competitive civil service examination has been ordered on June 26, at Albany, for the position of electrical expert under the State Railroad Commission. This position was created by the last Legislature, in order to secure a competent person to look after the construction of electric railroads. Candidates must be electrical engineers, thoroughly conversant with the construction and operation of electrical railroads and power stations, and competent to inspect and make reports on them in all departments.

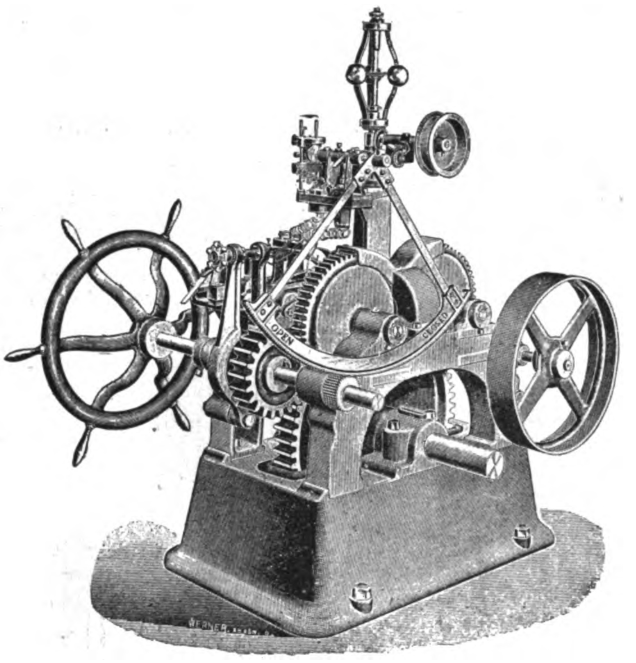
Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

REPLOGLE RELAY WATER-WHEEL GOVERNOR.

WE illustrate herewith the new "Relay" water-wheel governor built by the Replogle Governor Works, of Akron, Ohio, which has recently been submitted to a most successful test upon electric street railway work, which is perhaps the most severe service to which it could be put.

In this test it was intended to show what can be done in the extreme cases, and it was the aim to have the test made under



THE REPLOGLE WATER WHEEL GOVERNOR.

the very worst conditions. The time chosen was during a heavy snowstorm, with fully three inches of new snow on the track, and the success in obtaining bad conditions is fully shown by the fact that the circuit breakers opened ten times during a thirty minutes' test. This, of course, makes instantaneous changes of from full load to no load. It is shown that in only one case did the speed rise to slightly exceed 5 per cent. from normal.

The electric railway in question is that of the Citizens' Street Railway Company, Fishkill-on-Hudson, N. Y., connecting with Matteawan and Fishkill villages. There are seven miles of road. The maximum grade on this road is 8½ per cent. There are two portions nearly one-half mile long each, that average about 5 per cent. grade. There are some short curves and some of them are found on the heavy grades. The main line is giving a ten-minute service, and the suburban line an hourly service. At the time of the test four double motor cars were in operation, using from 30 to 50 horse-power each.

The power for this road is furnished from a pair of forty-eight-inch Rodney-Hunt water-wheels, under about fifteen feet head of water, and is conveyed by belts to a countershaft, which in turn drives by belt a General Electric "M. P. 100" generator. During the test readings were taken from a Shaeffer & Budenberg tachometer, a Weston voltmeter, and a General Electric Company ammeter. The readings began at 12:38 p. m., and were taken every ten seconds for thirty minutes. The normal speed was 105 revolutions per minute on the wheel shaft, and the average voltage was 550. The readings showed that there were 80 amperes of current, 540 volts pressure, and 103 revolutions on water-wheel shaft, at the end of the first minute. At the end of the second minute there was no current, 546 volts and a speed of 104 revolutions on water-wheel shaft, and twenty seconds later there were 110 amperes used, and the voltage had dropped to 516. The reading ten seconds later showed no current, 564 volts and 107 revolutions. Over one-half of the load dropped off in ten seconds, and yet the speed was only two revolutions above normal. This is less than 2 per cent. increase of speed on a 55 per cent. decrease of load.

At twenty-six minutes and forty seconds the readings were 200 amperes, 529 volts, and speed 101. During the following ten seconds the circuit breaker went out, and at the end of these ten seconds the readings showed 140 amperes, 560 volts and 105 revolutions, normal speed.

The above test shows clearly that water-power government has advanced to such a stage that it is safe and reliable, even under the most severe conditions, and it will therefore, we believe, be of considerable interest to street railway and electric power operators.

WILLYOUNG IMPROVED INDUCTION COILS AND VARIABLE CONDENSERS.

MESSRS. E. G. WILLYOUNG & CO., of Philadelphia, have recently placed on the market an improved line of induction coils which are intended to compare in quality with the best types of foreign make, but at very much lower prices. Fig. 1 illustrates the new Willyoung coil, from which it will be seen that the general plan of construction, especially as regards the "hammer head" vibrator, is similar to the English Apps coils, the most famous of which was made for Mr. Spottiswood and gave a spark in excess of forty inches.

The iron core in each coil is of best grade Norway iron wire, especially annealed, and each component wire is covered with a thin coat of shellac. The core lies inside of the primary coil and is inclosed in a hard rubber tube of sufficient length to render impossible any sparking of the secondary coil to the core or the primary coil. The secondary coil is wound in a large number of small sections each insulated from its neighbors, and the coil as a whole saturated with special insulation by an original method, in such a manner as to thoroughly exclude air, thus preventing any heating of the solid dielectric by bombardment, and consequent ultimate softening and breakdown of the insulation.

The electrical constants of the Willyoung coils have been determined with such care and accuracy that high efficiency is obtained, the maximum guaranteed spark being secured by minimum amount of wire in secondary coil and with least possible weight of the iron core. For example, in coils of six, eight, and ten-inch spark rating, not more than one pound of No. 34 B. & S. wire is used per inch of spark length, while the discharge in each case is exceptionally solid and heavy.

A new feature of great importance incorporated by Messrs. Willyoung & Co. in their induction coils is a variable condenser as substitute for one of single value as placed in the base of coils of ordinary design. The function of a condenser, as is well known, is to return through the primary coil the energy of self-induction produced in it at break in order to hasten

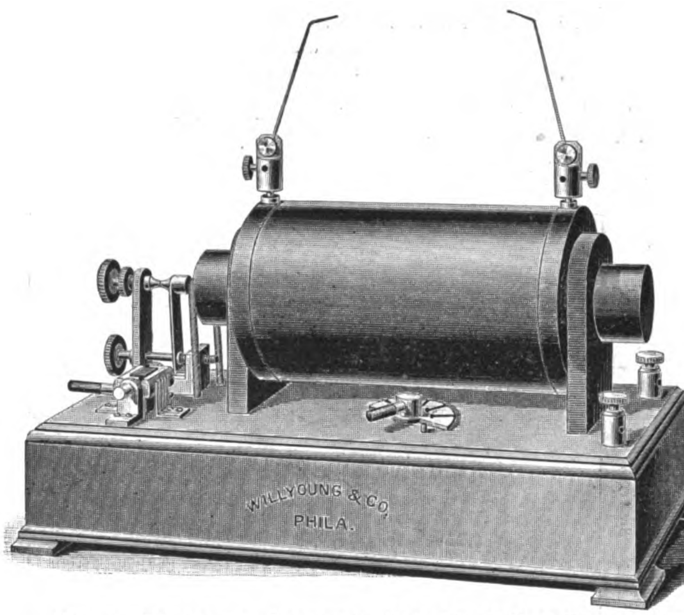


FIG. 1.—WILLYOUNG INDUCTION COIL FOR X-RAY EXPERIMENTS.

the demagnetization of the iron core and thus produce a sudden rise of E. M. F. in the secondary coil. As this self-induction energy depends upon the value of the primary current in use it will be evident that a condenser of but one capacity is only suited for a particular exciting current and a particular primary spark length, without variation in either case. Even

the change in electrostatic capacity produced by varying the vacuum tube (such as in X-ray work) is sufficient to disturb the proper balance between self-induction and capacity. This not only reduces spark length in the secondary coil, but causes actual heating and combustion of the primary sparking points, with the result that repairs are often necessary.

Messrs. Willyoung & Co. are also making a line of variable condensers for general experimental work, such as the study of resonance phenomena, alternating current investigations, etc. Fig. 2 represents a ten-microfarad variable condenser with ten sections of 1-10 microfarad each and nine sections of one microfarad each.

The method of construction will meet a demand for condensers, the capacity of which can be varied much more quickly and by much finer subdivisions than is possible in the

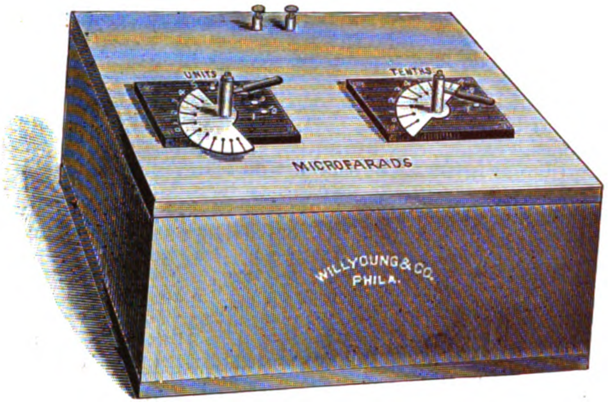


FIG. 2.—WILLYOUNG VARIABLE CONDENSER.

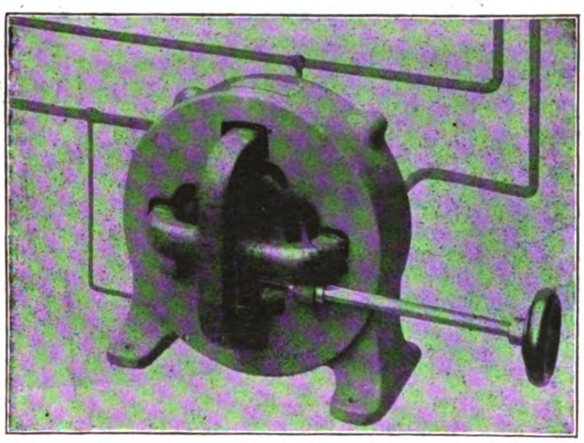
former "plug-in and plug-out" forms. The regulating switches, as in a controlling rheostat, instantly change the condenser capacity with perfect smoothness of operation and effect.

For material of construction, tinfoil and a specially selected brand of unsized paper are cut to proper dimensions and stacked together dry. These pieces are then subjected to a peculiar insulating process by which every part is permeated with a solid dielectric. Both air and moisture are thoroughly and permanently removed. The condensers are capable of "standing up" continuously and without injurious heat effect on 500 volt alternating circuits, while direct currents of much greater potential can be safely employed.

All the apparatus manufactured by Messrs. Willyoung & Co. is sold through their sales agent, Mr. James G. Biddle, 944 Drexel Building, Philadelphia, who will be glad to send descriptive circular, No. 170, to interested parties.

G. E. FEEDER POTENTIAL REGULATOR.

A SIMPLE and practical device for controlling the voltage on alternating current circuits is the new feeder potential regulator, type M. R., constructed by the General Electric Company, in which, by the mere turning of the iron core by



G. E. FEEDER POTENTIAL REGULATOR.

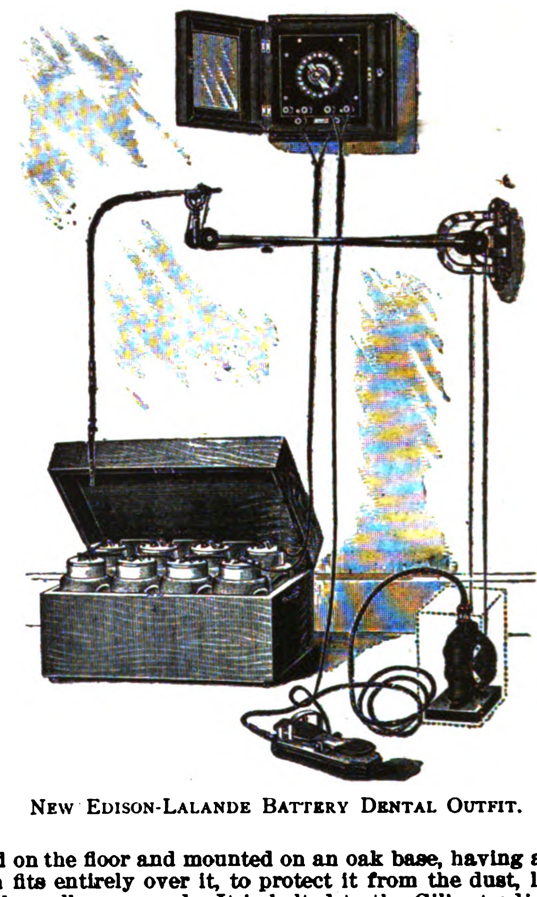
a small hand wheel, the effective voltage is raised or lowered, no movement of contacts or changes of connection being necessary. The principle involved is that of varying or reversing the mutual induction of the coils by change in position of the iron core, one coil being connected in shunt to the circuit, the other in series.

The utilization of this principle permits of continuous variation in the voltage as the core is turned without any of the abrupt, intermittent steps so noticeable with other devices for feeder regulation. This regulator acts as a transformer, not as a reactive coil; its effect in raising or lowering voltages is practically independent of the current in the circuit to which it is connected.

In construction the device is extremely simple, and consisting, as it does, of laminations of simple form and large machine wound stationary coils, it is practically indestructible. The uses of this regulator are numerous. It may be employed as a regulator for controlling the voltages on alternating current feeders; as a dimmer for theater lighting; as a controller for series street circuits and as a pressure adjuster on different branches of unbalanced polyphase or three wire circuits. It may also be employed as a transformer of adjustable ratio wherever it is desired to obtain alternating currents of variable pressure. It can, of course, be wound for any voltage.

NEW EDISON DENTAL BATTERY OUTFIT.

WE illustrate below a new dental battery outfit just brought out by the Edison Manufacturing Company, a brief description of which may prove interesting to our readers. The battery consists of eight cells of the well-known Edison-Lalande battery, type "W," which is largely used for battery dental outfits, on account of its long life, freedom from waste and absolute constancy of current. The reversible motor is



NEW EDISON-LALANDE BATTERY DENTAL OUTFIT.

placed on the floor and mounted on an oak base, having a cover which fits entirely over it, to protect it from the dust, leaving only the pulley exposed. It is belted to the Gilbert adjustable arm by a round cord belt similar to that used on the foot engine.

The reversing foot-switch is fitted with forward and backward movement, and also instantaneous stop attachment, when the motor is running in either direction. The rheostat is equipped with two sets of binding posts, one of them being for the motor connection, and the other for attaching an electric plugger, mouth lamp, hot-air syringe, or electro-cautery, as may be required, it being so constructed that it will regulate the current perfectly for all these various devices.

The Gilbert wall bracket has an adjustable movement which enables it to be raised or lowered through an angle of 30 degrees, thereby avoiding the necessity of raising or lowering the chair. It has also an extension movement of about twelve

inches which can further be used as a belt tightener. The upright socket at the end of this wall bracket is of the standard size to enable any S. S. White engine head to fit into it without alteration. The engine head can therefore be removed at will from the foot engine, and attached to the electric engine without a moment's delay. This bracket is elegantly finished throughout in polished nickel, and is of handsome design.

ERICKSON OUTLET INSULATOR FOR IRON CONDUITS.

THE general adoption of iron and steel armored conduits for interior wiring of fireproof buildings has led to many improvements in the perfecting of specialties in connection therewith. Prominent among these is the Erickson outlet insulator,

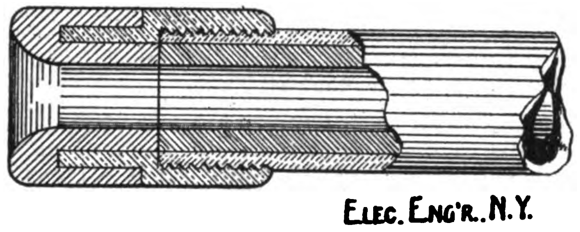


FIG. 1.—THE ERICKSON OUTLET INSULATOR FOR IRON CONDUITS.

handled by the Lord Electric Company, of 181 Tremont street, Boston, Mass.

The outlet insulator, shown in section in Fig. 1, consists essentially of a metal nozzle, tapped at one end to receive the conduit. The other end is encased in a molded insulating shell or armor which forms a finishing terminal for the emergence of the wires from the conduits.

In Fig. 2 an approved method of outlet construction is shown. It will be seen that only the insulating portion projects beyond the plaster line, in which case there is perfect immunity from grounding of the wires or canopy on the conduit armor.

The many possibilities of grounds and short circuits due to

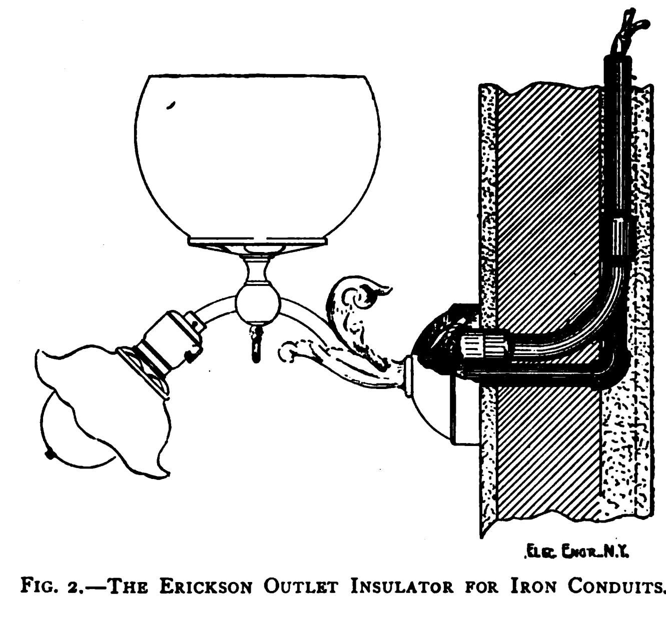


FIG. 2.—THE ERICKSON OUTLET INSULATOR FOR IRON CONDUITS.

the abrasion of the insulation of the wires by burrs at the ends of the conduits make this device an invaluable adjunct to conduit work. Engineers and contractors will readily appreciate the advantage of this appliance in installations under their supervision, where only first-class work is tolerated.

H. W. JOHNS MANUFACTURING CO.

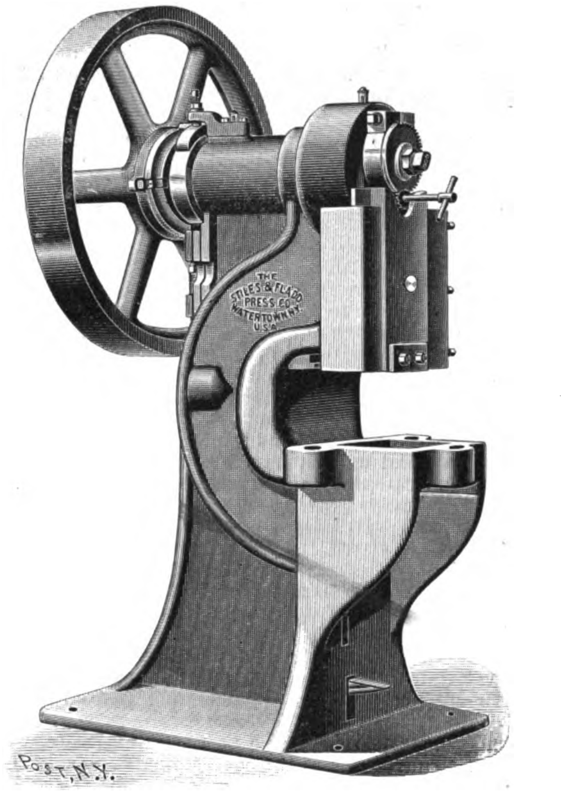
We are in receipt of the June catalogue of electrical materials issued by the H. W. Johns Manufacturing Company, in which they call particular attention to their new electric street car heater. The heater is durable in construction and economical in operation. The wires are not liable to oxidation, as they are protected from the atmosphere by a covering of asbestos which also forms a complete electrical insulation for them.

The wire after being wound with an asbestos thread is woven into cloth with an asbestos warp. A piece of this cloth containing a required amount of wire is fastened with fireproof insulating cement to a sheet of asbestos millboard, which forms its support. The whole is then covered in a case of perforated steel plate which is japanned with an insulating compound.

These heaters admit a free circulation of air through and under the perforated plate, the latter being arranged so that the back of the heater is half an inch in front of the panels below the seat. The heaters are controlled by a knife switch which can be adjusted to give three degrees of heat.

STILES & FLADD PRESSES.

The accompanying illustration shows a press of the improved type manufactured by the Stiles & Fladd Press Company, of Watertown, N. Y. In the construction and design of these punching presses every strain has been carefully considered, and the metal is so disposed as to best resist these strains and at the same time to provide for a limit of safety. Only a special mixture of iron is used in the castings of these presses, and this mixture is constantly tested so as to keep it up to the established standard. All the parts where wear occurs are care-



STILES & FLADD POWER PRESS.

fully scraped to fit exactly, thus providing perfect bearing surfaces.

The special feature to which attention is directed in this press is the clutch, which is a recent improvement upon the original Stiles clutch. This makes it possible to run the press in either direction equally well, and as the clutch acts practically instantaneously it leaves it within the power of the operator to make a whole or only a part revolution of the press which is a valuablue feature in preventing accidents both to tools and operators.

The presses are made in eleven different sizes, the six smaller sizes being fly presses and the five larger ones geared. They can all be readily adapted to electric driving.

NAVY ELECTRICAL SUPPLIES.

The Navy Department, through the Bureau of Supplies and Accounts, is inviting proposals until June 20 for furnishing the New York Navy Yard with one moderate speed dynamo, and other electrical apparatus and supplies for the New York Navy Yard.

ERIE CITY IRON WORKS.

The widespread development in electrical work has given rise to a marked tendency to specialization in the manufacture of steam plants. Prominent among the firms which now concentrate themselves mainly on the turning out of powerful

steam outfits for central station and other electrical purposes, is the Erie City Iron Works, Erie, Pa., and that their experience in this branch of work is appreciated in the trade is shown by the many large and important equipments they are credited with having made. Their specialties are high speed Corliss automatic, high speed single valve automatic, and medium speed single valve automatic engines, as well as Caldwell water tube boilers, and all styles of fire tube boilers. These are made of every desired dimension and power.

I-T-E CIRCUIT BREAKERS.

The Cutter Electrical and Manufacturing Company, 1112 Sansom street, Philadelphia, are sending their friends a handsomely illustrated catalogue descriptive of the I-T-E automatic magnetic circuit breakers for railway, light and power switchboards, motor cars, motors, house service and storage batteries. These are made for both direct and alternating current circuits. The electromagnet of the circuit breaker is designed to develop more energy than is merely needed to trip the retaining catch, this additional energy being employed to aid in opening the main switch. This makes a very quick and positive opening of the main switch when it approaches a condition of short circuit. The time of opening the circuit becomes smaller and smaller as the conditions approach more nearly a short circuit. The opening of the circuit breaker is positive in its action, and the adjustment is regulated by the use of weights and fixed distances, springs being entirely avoided as unreliable. They have ample carrying capacity and excellent provision is furnished for the line connections.

THE DODGE COAL STORAGE SYSTEM ON THE ERIE RAILROAD.

The Erie Railroad Company, after careful investigation and the consideration of a number of plans, have contracted with the Dodge Coal Storage Company, of Philadelphia, Pa., for a 150,000 ton storage plant at East Buffalo, N. Y. The coal will be stocked in nine divisions or piles, each of about 17,000 tons capacity. The plant will be constructed under the patents of the well-known Dodge system, with the latest improvements, including a complete haulage system for handling the cars. The efficiency of the Dodge system is demonstrated by the fact that every railroad using it has contracted for a second plant after more or less extended experience with the first.

ELECTRIC CAR LIGHTING FROM THE CAR AXLE.

THE National Electric Car Lighting Company, 34 Broad street, New York, have so far interested the Pennsylvania Railroad Company in their new method of car lighting as to now have a practical test made by the latter company on their cars, which leave New York for Philadelphia at 4 p. m., also on the well-known "Owl" train from Philadelphia at 12 midnight. Briefly described, the mechanism and power employed by this company to produce 14 to 16 candle-power electric lights in railroad trains is located and produced entirely on the truck of the car. The power is derived from the revolution of the car axles. Storage batteries, which are charged for five hours, but can run for twelve, are also placed on the truck.

Thus far, 4,000 miles have been covered by cars with this system of electric car lighting, and we are informed by Mr. Max E. Schmidt, of the National Electric Car Lighting Company, that the lighting system is coming up to the entire expectations of both parties concerned.

NEW YORK NOTES.

MR. H. ALEX. HIBBARD, dealer in electrical supplies, at 621 Broadway, has associated with him Mr. Otis Sheldon, and the business will be conducted hereafter under the firm name of Hibbard & Sheldon.

W. D. FORBES & CO., 304 Hudson street, Hoboken, N. J., are running their factory night and day, turning out large orders for machinery and specialties, such as high-speed engines for dynamo driving, milling machines, and other machine tools.

MR. NORMAN HUBBARD, 93 to 97 Pearl street, Brooklyn, N. Y., has good orders for his vacuum pumps, which he manufactures for incandescent lamp exhaustion, and is busy on a contract which has been awarded him for a part of the iron work on the new extension of the Brooklyn Bridge.

THE CHESLEY ELECTRIC COMPANY, 601-605 Newark street, Hoboken, N. J., are facilitating their work by putting in new boilers and engines. They are quite busy on general repair work and report satisfactory sales in second-hand electric machinery, which is their specialty. This firm has a New York office in the Havemeyer Building.

DALE, FARRELL & CO., of 413 East 25th street, are busy at work with a force of fifty-eight men, making up their "Volto" battery, bicycle lamp, magneto bells, car fenders, bicycles, etc., Lack of material for certain parts prevents them from delivering the large orders received for some of their goods. Mr. Dale reports as soon as these delayed adjuncts can be procured the factory will probably be worked to its fullest capacity with a force of from 200 to 300 men.

STUCKY & HECK, 35 New Jersey Railroad avenue, Newark, N. J., have recently received an order for thirty railway armatures, and with their splendidly equipped factory and a force of about forty hands are kept busy turning these out, as well as doing a large amount of repair work, their principal business. This firm works only on orders and has special facilities for turning out goods at short notice. Transformer work, commutators, new armatures for lighting machines and the like are their specialties.

JACOB BROMBACHER & SONS, 31 and 33 Fulton street, Brooklyn, N. Y., have for the past six months put on the market their improved gas engine to be used in conjunction with the Excelsior dynamo, which is giving excellent satisfaction. It runs 100 sixteen candle-power incandescent lamps at full wattage, and at an average cost of not more than 25 cents per hour. The voltmeter does not vary over two volts. This firm exhibit the workings of the entire plant, including meters, from 3 to 6 p. m. daily.

THE SUTTON MICROPHONE TRANSMITTER, illustrated in our issue of last week, has been assigned to the Phoenix Interior Telephone Company, of 157 Greenwich street. This is the granular carbon transmitter with which they have been so successful during the past few months and upon which letters patent have just been issued. These transmitters are guaranteed not to pack; in fact, the company will repack free of charge all transmitters which at the end of a year's service deteriorate or are any different from the day they were put up.

MR. L. W. KINGSLEY, secretary of the Mica Insulator Company, 218 Water street, New York, sailed June 3, on the steamship St. Louis, for a trip abroad, where he will spend considerable time in sight-seeing, as well as looking after the affairs of the company in Europe. The company's business is largely increasing in foreign countries, which is due to the high grade of insulation "micanite" they are furnishing the manufacturers of electrical machinery of the European countries, from their newly equipped factory, which is located at Stoke Newington, London. Upward of 100 hands are given employment. The company's London office is at 12 Camomile street.

WESTERN NOTES.

TACOMA, WASH.—The Central Electric Manufacturing Company, of Tacoma, has been organized, with a capital stock of $50,000. The incorporators are E. E. Salisbury, A. E. Dean and others.

THE NUTTING ELECTRIC COMPANY, of Chicago, are in bad shape, and in behalf of the Morgan & Wright Company the Chicago Title and Trust Company has filed its acceptance as receiver for the concern.

BOWERS BROTHERS, Lake street, Chicago, have just received a handsome medal and diploma awarded by the World's Columbian Exposition. The award is made for the pureness, transparency, and superior quality of the mica, which they exhibited at the World's Fair.

THE MASON ELECTRIC EQUIPMENT COMPANY, Chicago, who are agents in that territory for the Fiberite Company, Mechanicville, N. Y., and the Lafayette Engineering and Electric Works, Lafayette, Ind., have removed their offices from No. 307 Dearborn street to No. 1202 the new Fisher building, Dearborn and Van Buren streets, Chicago.

THE C & C ELECTRIC COMPANY have opened a branch at 311 Dearborn street, Chicago, where they have secured a fine show room and office, and it is their intention to keep a considerable stock of their well-known dynamos and motors always on hand. Mr. J. Holt Gates will look after their interests at the Chicago end, and hopes to secure a good share of the Western trade.

THE ELECTRIC APPLIANCE COMPANY are meeting with considerable success in the use of Packard Mogul lamps for lighting parks and summer gardens. One of Chicago's largest pleasure resorts of this kind, Fisher's Garden, near Lincoln Park, has been lighted entirely with Packard Mogul lamps for two seasons with such success that the Electric Appliance Company are making special efforts to extend the use of the Mogul lamps for this class of work.

Department News Items will be found in advertising pages.

THE
Electrical Engineer.

Vol. XXI. JUNE 24, 1896. No. 425.

ELECTRIC TRANSPORTATION.

THE JOHNSON-LUNDELL RAILWAY SYSTEM.

OF the various methods of electric street car propulsion which have been exploited, the overhead trolley, the underground trolley, the storage battery and the surface contact, the latter has received the least attention of any, although in some of its aspects it presents advantages which none of the other methods can claim. The general plan of picking up the current from points on the surface of the road which are alive only during the time the car passes over them, has been studied by many inventors during the past ten or fifteen years, but up to the present time but little that has proved practical has been achieved.

A good working example of the surface contact system invented by Messrs. E. H. Johnson and Robert Lundell, has been in operation on West Thirty-fourth street, New York, for about four months and embodies some novel and important points in its construction. The road, illustrated in Fig. 1, extends from Tenth avenue west to the Hudson River, a distance of about one-third of a mile, is double track, or exactly 3,540 feet of single track. There are 148 manholes or switch boxes alongside of the tracks, each manhole containing two switch magnets.

In order to follow the operation of the system the reader is referred to the diagram, Fig. 2, which shows the connections of circuits and working parts. A storage battery, B, consisting of 200 cells, of small capacity, is divided into halves and placed under both ends of the car beneath the floor. This battery is used on starting the car only, except when it may be

FIG. 1.—VIEW OF JOHNSON-LUNDELL CAR AND TRACK, NEW YORK.

called into use by some emergency, such as the crossing of steam railways, etc. Its main function, however, is to start the switch magnets when the car is standing still and the switch magnets are all open.

Suppose the car to be situated as in Fig. 2, and that the motorman starts it by closing the switch Sw. The current will then flow from the positive pole of the battery through wire w^{11} to switch Sw, through resistances and conductor w^{10},

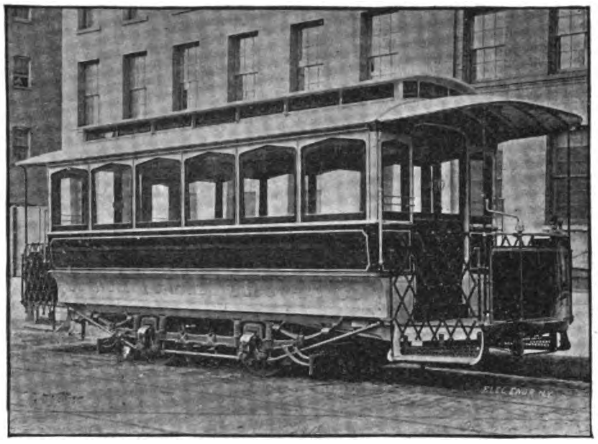


FIG. 3.—JOHNSON-LUNDELL ELECTRIC CAR.

through the motor M and wire w^{12} to contact-shoe S^2 and thence to sectional trolley-conductor Sc^4; thence by wire w^4 through a coil around the switch-magnet M^2, and also through a coil around switch-magnet M^3, energizing these two magnets, and finally to track-rails R and R′, car-wheels, and negative pole of the battery.

This battery current is sufficient to start the car under way, but its main function is to move the switch levers, p^2 and p^3, which close the connections between the branch feeders, Fw^2, Fw^3, and the sectional trolley conductors, Sc^3 and Sc^5. In this position of the switch magnets, which are closed by the battery current, the line current passes up over the line, w^3, to the contact shoe S′ and through the wire, w^9 to the switch Sw, at which the current is divided into two parallel circuits. One of these circuits passes through the line w^{11} to the battery, which it charges, as the line circuit is of a higher potential than the battery circuit. From the battery the charging current passes through the wire w^{13} to the car axle, and then to the track which forms the return circuit.

The other parallel circuit from the switch Sw carries the line current through the wire w^{10} to the motor M, then through wire w^{12} to contact shoe S_2. From this contact shoe the current is conducted by Sc^4 through wire w^4 to the coils of the magnets M^2 and M^3 in the same directions as before, and from M^3 it passes to the track return, R R′, completing the circuit.

It will thus be seen that the coils of the magnets M^2 and M^3 are in series with the motor M, and that in consequence the switch-levers p^2 and p^3 will remain closed as long as the propelling current flows through conductor w^4.

If the car be moving from right to left, it will be evident at a glance that the sectional conductors Sc^5 and Cc^7 are made alive in advance of the contact-shoe S′; but it remains to be seen if this holds true when running in the opposite direction. Suppose the car starts from the position shown and moves to the right instead of to the left. All connections will then remain undisturbed as long as the contact-shoe S^2 is still upon the sectional conductor Sc^4; but when the shoe S^2 closes contact with sectional conductor Sc^3 and finally breaks contact at Sc^4 the propelling current will simply be shifted from wire w^4 to wire w^2. This, however, energizes magnet M′ instead of magnet M^3, and magnet M^2 remains undisturbed, leaving the branch feeder Fw^2 in connection with Sc^3. As the shoe S′ now approaches sectional conductor Sc′, the lever p′ will have closed connection between the branch feeder Fw′ and the sectional

conductor Sc', thus illustrating that the system of interconnections between switch-magnets is adapted to work both ways.

It will be apparent from an inspection of the diagram, Fig. 2, that the maximum time allowed for each magnet to close is equal to the time the car takes to travel the distance between the sectional conductors Sc^2 and Sc'. It will also be noted that the high-potential sectional conductors Sc', Sc^2, Sc^3, and Sc' are in direct connection with the contacts l', l^2, l^3, and l' in the switch-boxes without any of the coils around the magnets being included in circuit, so that in case the insulation o. one of these sectional conductors should become impaired, the leakage-current cannot hold the magnet closed and therefore cannot keep the conductor alive after the car has passed.

On the experimental road in Thirty-fourth street the line current has a potential of 500 volts and the car, Fig. 3, contains 200 cells of accumulators, which allows the latter to be charged at their maximum rate of 2½ volts per cell.

The location of the surface contacts is shown in Figs. 4 and 5, which are reproductions of photographs taken while the roadbed was under construction. The former illustration shows these castiron contacts standing upon a block of insulating material and fastened on top of the ties by lag screws, which are insulated from the contact column. Fig. 5 shows the same view, taken after the contacts were surrounded by a covering of rock asphalt except upon the top surface, where contact with the skates S' S^2 is made. They are placed in the roadbed with their upper contact-surfaces slightly higher than the pavement. To minimize leakage in wet weather they are made as short as possible, and to prevent any sectional conductor from being alive in front of or after the car they are placed at such distances apart that the platforms of the car will safely cover both the conductor which is doing service and the one which is made ready for service.

The battery, as stated above, is of an electromotive force approximating that of the line, so that it will always be fully charged and ready to do service when called upon. It may also be of such capacity as to be able to propel the car for short distances across turnouts, crossings, switches, etc., where the electric equipment of the roadbed would present natural difficulties. The battery will thus propel the car independently of the station current by closing the switch Sw and also another switch, not shown, which is placed on the center of the car platform and which closes a connection between the wires w^{12} and w^{13}. This switch may also be arranged to break the connection between the switch Sw and the contact shoe S'.

At Eleventh avenue the road crosses the tracks of the New York Central Railroad and at this point the electrical equipment is interrupted and the car either crosses simply by momentum or by means of the storage batteries. On the 3½ per cent. grade between Tenth and Eleventh avenues the electrical contact equipment is also omitted on the down grade side of the tracks. All the current necessary at this place is that which may be required to start the car, and this is supplied by the battery. In any case, after starting, the current would have to be turned off and the brakes applied, so where the grade is sufficient it is not necessary to equip the track with the contact system, as the battery is sufficient to meet all the demands for starting.

Fig. 6 shows two separate views of the switch magnets represented by M in the diagram, Fig. 2, and also the sectional conductor or contact piece. The coil in the center is the double winding by means of which the inter-connections of the switch magnets explained above are accomplished. The two rows of spring contacts on either side of the switch are connected by means of the carbon block which lies beneath and between them. The carbon block, as it appears in the lower figure of the illustration, is raised by the magnet to which it is attached against the springs when the current passes around the outside magnet frame. The switch acts instantly and positively and is held in position with as much force as a man can conveniently overcome with one hand. When the current is cut off the magnet the carbon bridge drops down instantly upon its seat, in the position shown in the upper view of the switch

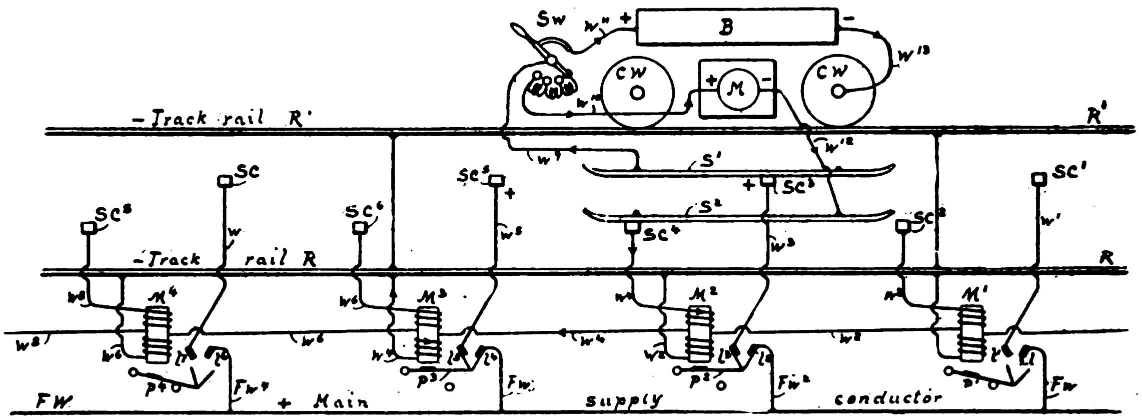


FIG. 2.—DIAGRAM OF CIRCUITS OF JOHNSON-LUNDELL SURFACE CONTACT STREET RAILWAY SYSTEM.

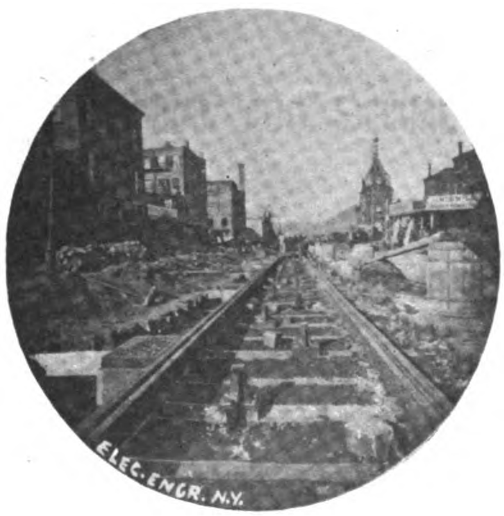


FIG. 4.—VIEW OF TRACK, SHOWING CONTACT PILLARS.

FIG. 5.—VIEW OF TRACK, SHOWING CONTACT PILLARS ENCLOSED IN ASPHALT.

magnet, without any signs of arcing. In placing these switches along the track they are put in manholes which are several inches deeper than the height of the switches. These manholes contain four pillars, upon which the switches stand, which raise them up near the top of the manhole boxes. They are then covered with a box in the form of a diving bell, so that no water or drainage can reach its upper part where the switch is located. The moisture cannot affect the movable part of the switch, as it is extremely loose fitting and is covered with a sheathing of brass to avoid any difficulty from corrosion.

When no car is running, and consequently no contact points are alive, there is absolutely no leakage possible on the system in any kind of weather, owing to the high insulation of the main conductor and switch magnets. There is also no leakage in dry weather when the cars are running. It is readily seen that when any leakage does occur it can only be at the point directly under a car where the contacts are alive.

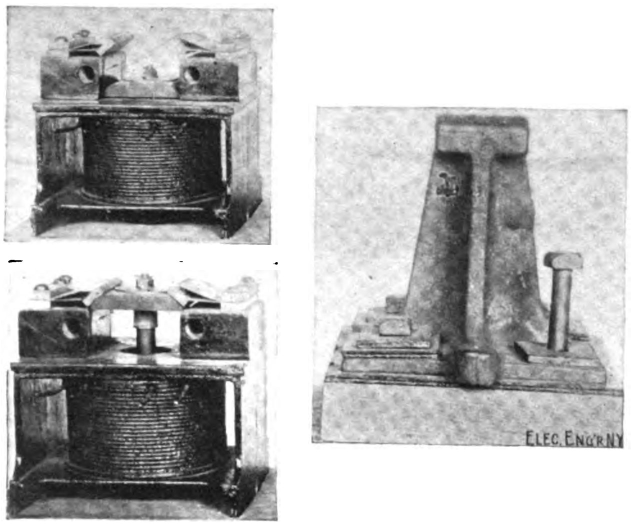


FIG. 6.—JOHNSON-LUNDELL SWITCH MAGNET AND CONTACT PILLAR.

During a rain storm, or immediately after, the leakage from a positive contact point is about ¼ ampere and from the whole contact bar about one ampere. The greatest leakage appears to be due to snow and slush during the winter, but no accurate data could be secured owing to the difficulty of taking readings while the car was running on a crowded street. On the day after a heavy snow storm when the track rails and contact points were entirely submerged in water and snow the leakage from the positive contact bar appeared to be only from 3 to 5 amperes.

A NEW TROLLEY ROUTE FROM WASHINGTON, D. C.

The interurban trolley line between Washington and Mount Vernon was recently opened for traffic as far as Arlington. The line is run somewhat on the plan of the ordinary suburban steam road, the trains consisting of three long cars equipped with airbrakes, compressed-air whistle, signal lanterns, green flags at the end, and all the paraphernalia of a regular steam road.

The cars will not stop anywhere and everywhere; passengers are required to buy their tickets at the stations, and in case they pay on board they are charged an extra fare, and given a rebate check of the conventional pattern. The route selected winds its way through rather obscure city streets, where the underground trolley is used, until it reaches the Long Bridge. Here the overhead trolley comes into play. The electric trains are switched directly on to the bridge tracks of the Pennsylvania Railroad, over which they run for a considerable distance. A railroad of the same kind as the Mount Vernon Road is now in process of construction between Washington and Baltimore, and this in turn is said to be but a part of a plan for eventually connecting the four great cities, New York, Philadelphia, Baltimore and Washington.

THE DUBLIN TRAMWAY 3-PHASE TRANSMISSION.

We illustrate herewith the sub-station switchboard connections of the Dublin tramway system, which our readers will remember was described at length in The Electrical Engineer of February 5, 1896. This station is of interest from the fact it is among the first to make use of a three-phase transmission for street railway work. The three-phase current, however, is not utilized directly to drive the cars, but is led to two transformer sub-stations, at Blackrock and at Dalkey, the former being 6,000, and the latter 12,600 yards from the generating station. At these points the three-phase current drives synchronous motors which in turn drive direct connected, 500 volt generators which feed into the trolley line. The diagram of connections shown is that of the Blackrock sub-station, and it differs very little in its general arrangements from that in Dalkey except as to the size of the units employed. This plant is composed of two direct coupled units, each consisting of a synchronous motor coupled direct to a 60 kilowatt direct current generator. The motor is run with a 2,300 volt three-phase current and the generator produces current at from 500 to 550 volts.

It will be seen that the three-phase mains are first connected to three-pole 50 ampere switches and from thence the current passes to the three-phase bus-bars. From the bus-bars connections are made to the various instruments and to the switches to the motors. It is necessary that the motors which

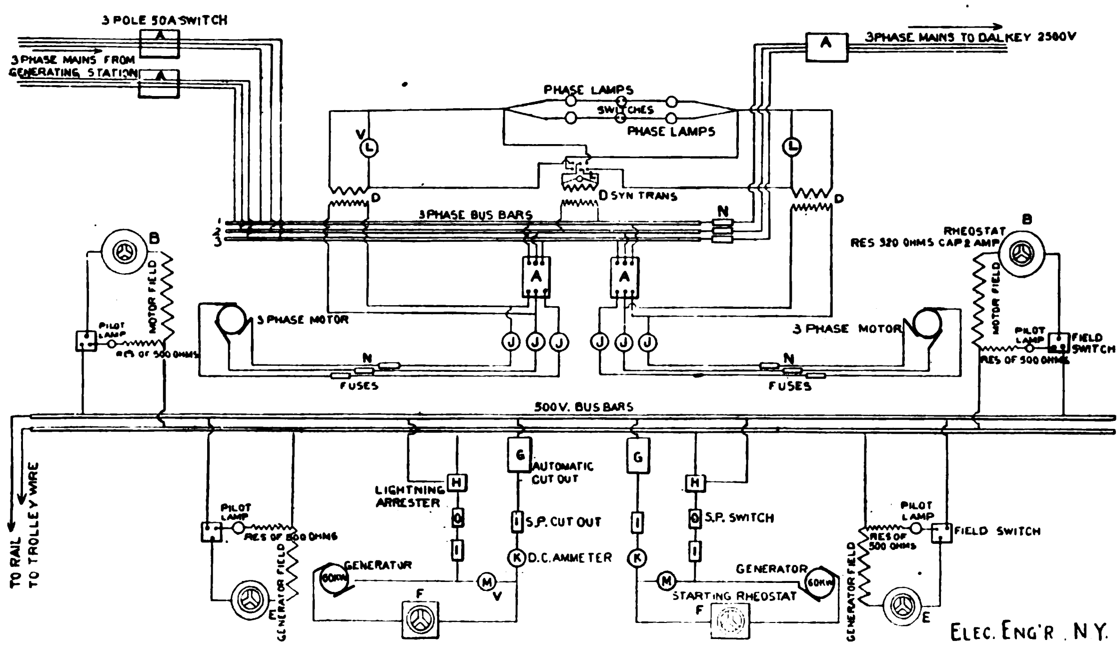


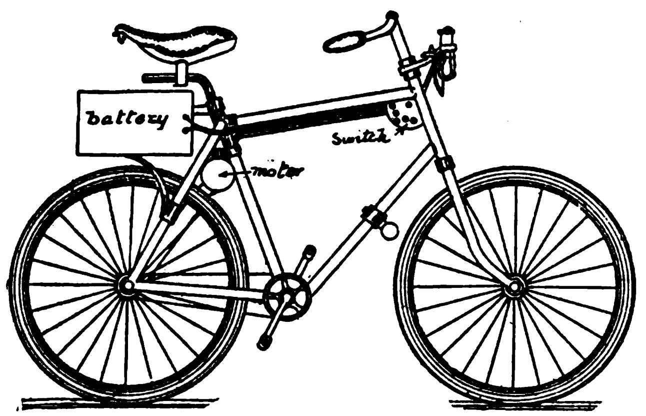
DIAGRAM OF CONNECTIONS OF DUBLIN-DALKEY THREE-PHASE RAILWAY SYSTEM.

drive the railway generators are not thrown on to the three-phase mains before they have arrived at synchronism. For the purpose of speeding them up, therefore, arrangements are made for diverting current from the trolley wire to the generator, thus causing it to run as a motor for a short time, and speeding up the real motor till it is in synchronism with the three-phase system. In addition there are on the switchboard switches for controlling the entry of the three-phase current, and the machines switching gear for the 500 volt circuits.

AN ELECTRIC BICYCLE.

THE latest innovation in the manufacture of bicycles is an electric motor attachment, the invention of Mr. James O'Brien, of New York City. The accompanying illustration shows the attachment, which supplies motive power for the bicycle and current for the electric headlight. The wheel is of the ordinary pattern and weighs twenty-seven pounds without the electrical attachment. With the latter the total weight is brought up to sixty lbs. The elecrical equipment consists of a battery, motor and switch. The battery is a dry chloride cell and its weight is about fifteen lbs.

From the illustration it will be seen that the electric attach-



AN ELECTRIC BICYCLE.

ments occupy comparatively little space. They can be easily detached, and the machine can be used in the ordinary way. Should the battery or any part fail, it is not necessary to remove these parts. If at any time the rider wishes to use the pedals instead of the electric power, a small switch will cut off the current.

The switch is placed in the illustration below the bar, but the inventor's latest improvement places it under the handle, so that it can be reached without trouble by the rider. A woven silk band is used to connect the motor with the hub of the rear wheel.

ELECTRIC RAILWAY EXTENSION IN CHICAGO.

Two hundred and twenty-five miles of electric road have been projected to haul Chicagoans to summer resorts in the torrid season and bring Wisconsin ice to Chicago. The deeds for the right of way from Evanston to Wilmot, Wis., are in the vaults of the Chicago and Inland Lakes Railway.

Besides touching eighty-one lakes and coming near a score of others, it is planned that branches of this newest venture in Chicago railroad building will touch Madison, Milwaukee and Lake Geneva. The road will traverse three counties in Illinois and seven in Wisconsin, and will at no point be less than two miles and at most points ten miles from competing roads. The officers of the company are: Alfred E. Case, president; S. Marcus Rothschild, vice-president; G. D. Green, secretary; F. Boden, treasurer, and A. J. Toolen, general manager.

CYCLING BY TROLLEY POWER.

Three cyclers riding abreast of a street car made a scene on Genesee street last evening shortly before 8 o'clock. The car was pacing the wheelmen at a speedy clip, and, partly to make the rate of progress uniform and more to produce the aforementioned scene, one wheelman laid his left hand on the car, and each of the other two boys put his left hand on his neighbor's right shoulder. The dynamo at the power house did the rest.—Buffalo "Courier."

POWER TRANSMISSION.

FORT WAYNE SINGLE-PHASE ALTERNATING MOTORS.

BY THOMAS A. NATHANS.

AMONG the interesting pieces of apparatus at the recent Electrical Exhibition were the single-phase alternating current power motors exhibited by the Fort Wayne Electric Corporation. These motors are strictly single-phase machines,

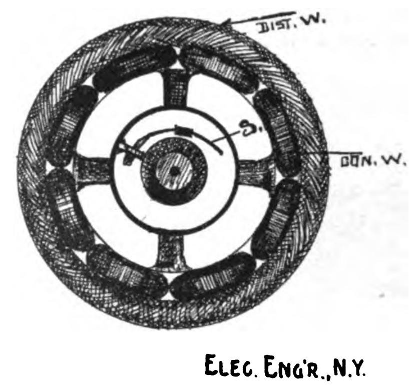


FIG. 1.—ARMATURE WINDINGS OF FORT WAYNE ALTERNATING MOTOR.

starting under full load without the aid of external apparatus, such as condensers, phase-splitting devices, etc. Running as synchronous motors and capable of being used as rotary transformers, they give to the single-phase alternating system every

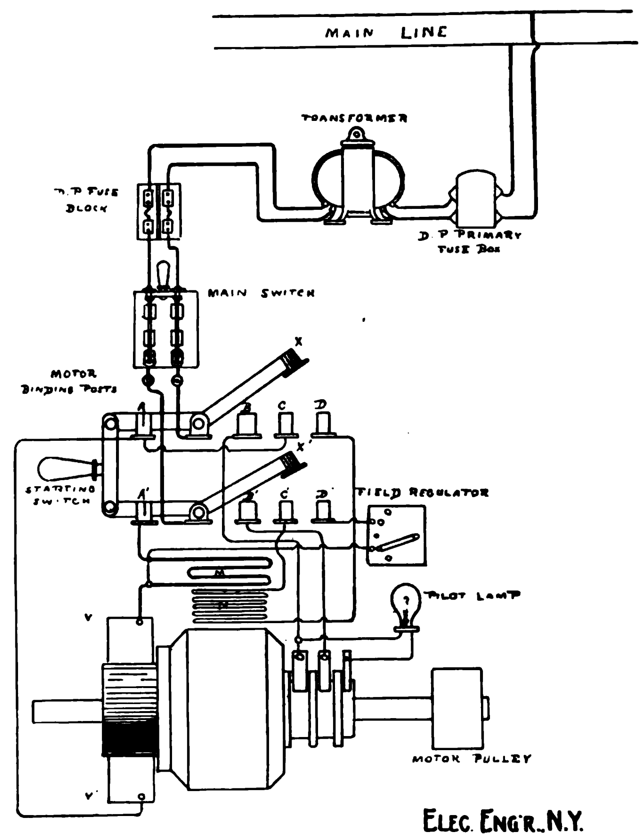


FIG. 2.—DIAGRAM OF CONNECTIONS, FORT WAYNE ALTERNATING MOTOR.

advantage of the low tension direct system with the additional ones of flexibility, and adaptability to long distance transmission.

The machines are strikingly simple, compact and durable. The armature is of the ring type, and carries two windings, one

a distributed winding, wound in the teeth on the periphery and connected to a commutator, which is placed on one end of the shaft; the other winding is a concentrated one, having as many coils as there are field poles, and connected to two collectors at the other end of the shaft. The relative position of these windings is shown in Fig. 1. The multipolar field is well laminated and resembles that of a large alternating current generator; it is also wound with two windings, one, a few turns of heavy wire, and the other a deep winding of fine wire. A double throw lever switch and a pilot lamp, both situated on top of the machine, complete its simple appearance.

By following the connections in diagram, Fig. 2, its small number of parts and practical construction will be clearly seen. Instead of the introduction of a phase shifting, transforming device, or choke coils, the secondary of an ordinary lighting transformer is connected to the binding post of the double throw switch after passing through the fuse box and main switch.

When the machine is not in use the starting switch is left so

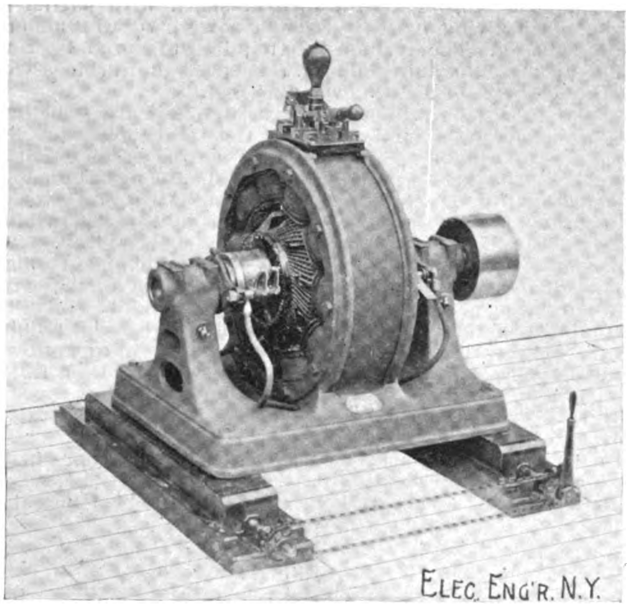


Fig. 3.—The Fort Wayne Synchronous Alternating Motor.

that neither of the lever arms engages with the connecting clips, AA′, BB′, CC′, DD′.

In starting, the handle of the starting switch is depressed, thus connecting the clips A and A′ to the circuit; the current is thus carried to the commutator end, then passes through the distributed winding of the armature, through the heavy winding of the field, M, and back to the source of supply. In other words, the machine is a simple series motor at the start, and with proper winding on the field it is well known that it will start up with a powerful torque. No rheostat is used in starting, as the self-induction of the field coils prevents an inrush of current, which would otherwise damage the machine. The motor starts under full load and rapidly speeds up.

Referring to the diagram, a small third collector ring is placed beyond the two regular ones, and beneath this auxiliary collector is placed a centrifugal spring, shown at S, Fig. 1, which is so adjusted by a sliding weight that it will make contact with the inside of the collector when the speed of the armature is a little higher than is needed for synchronism.

One of the terminals of the concentrated winding is connected to the inside collector, and the other is branched and is connected to the second collector and the standard that holds the centrifugal spring under the third collector. Hence, when the spring makes contact with the auxiliary collector, the pilot lamp on top, which is now connected between the first and third collectors, lights up at a dull red, due to the alternating e. m. f. induced in the concentrated winding from the distributed winding through which an alternating current is flowing. The lighting of the lamp is a signal to throw the switch. The switch is then raised, breaking the connection at the clips A and A′, and making two connections on the other side. First B and B′ are connected with the switch blades, and second the small bars X and X′, which are insulated from the blades, connect C with D and C′ with D′; the first connection feeds the alternating current from the transformer to the collectors, and the second closes a circuit from the commutator end, which was just filling the office of an alternating motor, but now that of a continuous current generator, through the fine winding of the field. The current starts, say, from brush Y′, going from C to D, through the fine winding, through C′ and D′ through a small rheostat, and back to brush Y. The motor now is connected up as a synchronous machine; its speed decreases a little until it falls into step with the generator. As the speed drops, the spring under the third collector breaks the circuit through the lamp and it goes out.

The rheostat is placed in the base of the machine, its handle being accessible through an oval opening on the commutator end. The object of this rheostat is to regulate the field excitation and it is set at the factory.

In starting with no load the time taken for the motor to reach synchronous speed is from five to fifteen seconds, depending upon the winding, and, when loaded, from fifteen to thirty seconds, depending upon the load. The current used at these times is from 25 to 50 per cent. in excess of what the machine requires when running in synchronism.

The motor can be adjusted for any starting torque by changing the heavy winding, and in case only a small torque is required at the start, as in running countershafting where the machines are thrown on independently, the required starting current is greatly reduced.

In spite of its simplicity, the machine may be used in a variety of ways. As a rotary transformer it can be used as a shunt motor, the speed of which can be varied by a rheostat, and alternating currents of any frequency can be taken from the collectors; or it may be run by an alternating current while a direct current is taken from the commutator. If the machine be driven from its pulley it may be used as a self-exciting alternator, and it may also be driven as a series motor by a direct current.

THE UTILIZATION OF WATER-POWER, ESPECIALLY WITH A SMALL FALL, WITH SOME EXAMPLES OF PLANT FOR THE GENERATION OF ELECTRICAL ENERGY.[1]—I.

BY ALPH. STEIGER.

THE cheap production of electrical energy is generally recognized to be one of the chief aims of modern engineering science. Nature has provided us in water-power with one of the best possible agents for realizing this object; and I trust that, in bringing the subject of the utilization of this free gift of nature before the members of the Institution of Electrical Engineers, I shall be able to convince them that the water-

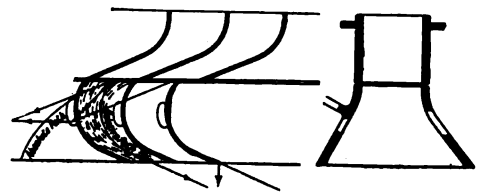


Fig. 1.—Vanes of "Action" Turbines.

powers of this country, if judiciously utilized, are capable of rendering them great service.

In my own country—Switzerland—the electrical engineer is co-operating cordially with the water-power engineer, and electrical installations are rapidly increasing in number. The successful electrical transmission of power to points far distant

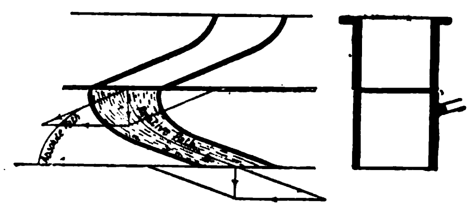


Fig. 2.—Vanes of "Reaction" Turbine.

from its source has been the chief factor in this development. The idea prevails that considerable fall is required to obtain water-power, but it is my desire to show and to prove in the following remarks that excellent results are obtainable also with a very low fall—a fall of even less than three feet. Small falls are more frequently met with in this country than high falls

1 Paper read before the London Institution of Electrical Engineers.

and will therefore have more particular attention in this paper than the high falls found in mountainous districts. The description of a few turbine plants under low falls, some of which are applied to the generation of electrical energy, will be of special interest.

During a long experience in constructing turbines and designing complete plants I have found that the most difficult were

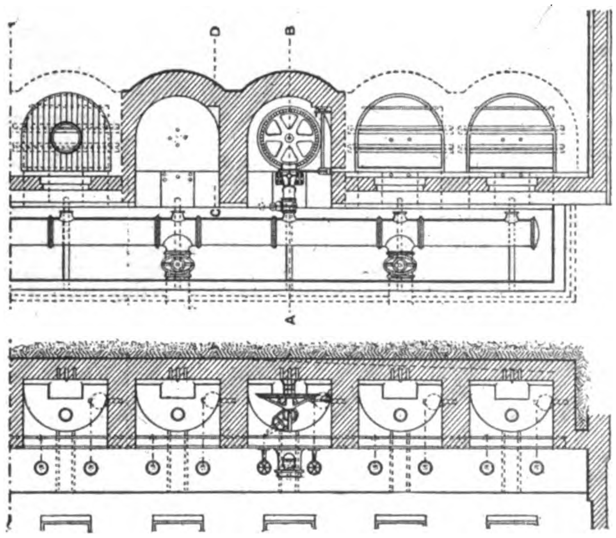


FIG. 3A.—TURBINES AT THE FALLS OF FOYERS, SCOTLAND.

always those connected with the utilization of a low fall. These difficulties consist chiefly in the variation within very wide limits of both the quantity of water and the fall, while a constant power, and in most cases a constant speed, is of great importance.

Generally speaking, the real agent in water power is gravity, and the water is simply the medium to transmit the action of gravity on to the motor which converts it into mechanical work. The action of gravity can take either the form of dead weight, or of pressure, or of velocity, sometimes called kinetic energy. A very high efficiency is obtained from motors in which the water acts by dead weight or by pressure, but the slow speed of the water wheels and the complicated mechanism of the pressure engines render them unsuitable for the purpose of generating electricity; moreover, motors worked by weight or by pressure are only advantageous when working under a high fall. The kinetic energy is the only form in which the gravity can be applied advantageously to the performance of mechanical work under a small fall. The motors using it in this form are the common undershot wheel, the Poncelet water-wheel, and the turbines. It will be sufficient for the purpose of this paper to give the efficiency of the various types of water motors for any fall without going into a detailed description of those which are unsuitable for driving dynamos. The efficiency of the motors, with the fall for which they are adapted, is as follows:

Fall. Feet.	Efficiency of water wheel.		Efficiency of turbine.
		Per cent.	Per cent.
1 to 5	Ordinary undershot	25 to 30	70 to 75
	Poncelet	65 to 70	
	Segebien	65 to 75	
5 to 8	Low breast	30 to 50	75 to 80
8 to 15	High breast	60 to 75	75 to 80
15 to 50	Overshot wheel	55 to 75	75 to 80
Above 50	Pressure engine	75 to 85	75 to 80

These figures show the interesting fact, that the smaller the fall is, the greater is the gain in power over the old-fashioned water wheels. Although the smallest fall which would reasonably be utilized by a turbine is at least 2 feet 6 inches, I will show by some examples that, by a turbine suitably constructed and carefully adapted, useful power is still obtained under a fall of only one foot, or a little over. The great variety of fall, water supply, local conditions, and special requirements, of necessity demands a variety of types of turbines.

Turbines are classified, according to the manner in which the water acts in them, into—(a) "impulse," or "action," turbines, and (b) "reaction" turbines; and according to their construction, into—(a) parallel flow turbines, (b) radial flow turbines, (c) mixed flow turbines.

There is an essential difference between the "impulse" turbine and the "reaction" turbine, as indicated by the form of vanes illustrated in the diagrams, Figs. 1 and 2.

The "impulse" turbine, as usually constructed, must run clear of the tail water, its buckets being only partially filled with water. It requires a constant fall, with constant level of the water in the head and tail race, but its efficiency is not affected by the greatest variation of the water supply. On account of this quality, it can be built as partial injection turbine, to utilize high falls with a very small water supply. If constructed as "partial injection turbine," its diameter can be chosen so as to give just the desired number of revolutions. This is extremely convenient for driving dynamos, which can thus be connected direct with the shaft of the turbine, doing away with intermediate gearing or belt drives. An instance of this kind is the turbine plant now being erected by Messrs. Escher, Wyss & Co., of Zurich, at the Falls of Foyers, for the British Aluminum Company (Limited). This plant consists of five "impulse" turbines with vertical shaft, with partial injection, each giving 700 British horse-power, working under a fall of 350 feet. The dynamos are required to run at 140 revolutions per minute, and to obtain this speed the turbines were given a diameter of a little over nine feet.

Partial injection turbines under a high fall are sometimes fixed on a horizontal shaft, and can thus be coupled direct to the armature spindle of a dynamo by means of an isolating coupling. This mode has been adopted, amongst numerous other plants, for the electric lighting installation of Davos, in Switzerland, which consists of three horizontal patent turbines of 200 British horse-power each, working under a fall of 330 feet, and running at 400 revolutions per minute. The turbines have a diameter of forty inches. As a contrast to these turbines of large power and small diameter, and to show the adaptability of the partial injection turbine to special requirements, the 140 horse-power turbines of the waterworks in Chauxdefonds may be mentioned. These work under a fall of only 170 feet, but as they are driving pumps at the low speed of sixty revolutions they had to be made of a diameter of fifteen feet.

Great as the advantages of the "impulse" turbines are under the conditions above mentioned, their use under very low falls is limited, firstly, owing to the reason already given that they

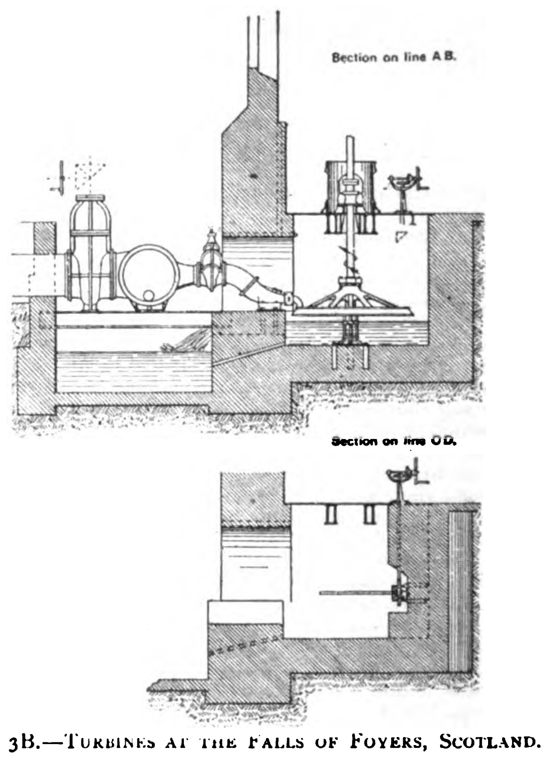


FIG. 3B.—TURBINES AT THE FALLS OF FOYERS, SCOTLAND.

must run clear of the tail water—a condition which can seldom be realized in a flat country like this; and, secondly, because they run at a slower speed than a "reaction" turbine under the same fall. Although "impulse" turbines are now built to run in the tail water without considerable loss of efficiency, the reduction of power in proportion to the reduced fall, and the quantity of water accordingly reduced, together with the reduced speed, excludes them in the majority of low and vary-

ing falls. The ideal turbines for low and varying falls are the "reaction" turbines. They are generally placed on a level with the tail water, or, if local conditions require them to be placed above tail water, connected with it by a suction tube. They run at a higher speed for the same fall, or the same diameter, than an "impulse" turbine, and their efficiency is not affected by the immersion in the tail water. The principal objection raised against "reaction" turbines in general is that their efficiency is greatly reduced when working at part gate. This is indeed the case with many of the reaction turbines known in this country, which give a very poor efficiency at part gate, especially at less than half gate. The continuity of flow of the water through the buckets is essential to a good efficiency. Only in a few reaction turbines is this condition fulfilled to such an extent that within very wide limits of the water supply the efficiency is not perceptibly reduced.

The utilization of a small and varying fall, with a varying quantity of water, is a very difficult problem for the water-

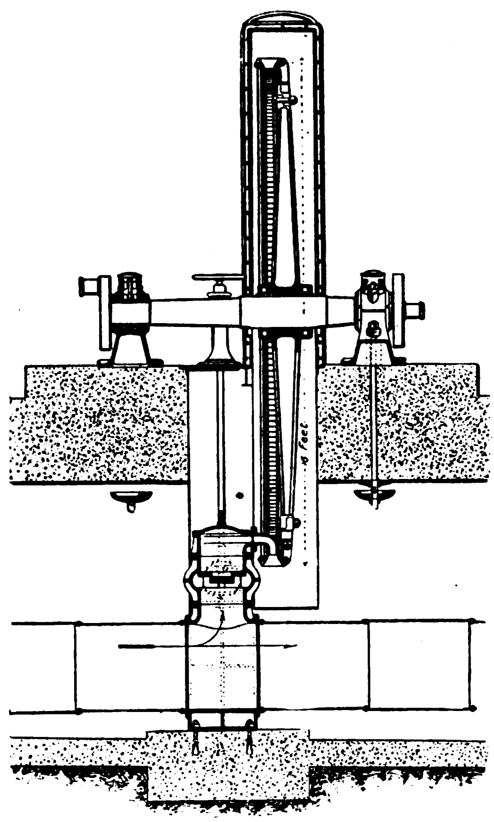


FIG. 4.—TURBINES OF THE CHAUX DE FONDS WATERWORKS, SWITZERLAND.

power engineer. The turbine for a given power under a low fall is larger and runs slower than one of the same power under a higher fall; it is, therefore, heavier and more costly, and requires heavier gearing, entailing a greater loss of power through friction. A high speed is desirable, especially for driving dynamos; but attempts to increase the speed of the turbine by reducing its diameter may easily result in an inferior efficiency. The efficiency should be as high as possible in consideration of the greater cost of a water-power plant with a low fall; but the proportion within which such a fall and the quantity of water varies is mostly so great that it is almost impossible to obtain the highest efficiency when the water supplied is diminished, i. e., when a high efficiency is most wanted. The maintenance of a constant power with a constant speed under variation of fall and quantity of water in large proportion can, if at all, only be attained by sacrificing some efficiency. The hydraulic losses must be reduced to a minimum by the most careful construction of the turbine in its essential parts, and it is needless to say that no standard size or type of turbine will fulfill all these conditions by simply consuming all the available water.

Even the arrangement of the turbine chamber is of influence on the results, and requires special attention. On a careful judgment of the local conditions depend the economy and the success of a plant. Unsatisfactory results in water-power plants are caused just as much, or oftener, by bad judgment of the local conditions as by the inferiority of the turbine.. In by far the most cases of low falls incidental to flat countries, an abundance of water corresponds with a reduction of the fall. The power of a turbine calculated for the normal fall would be reduced, for the time, when an abundance of water reduces it; and, as a consequence, water would be wasted, while the power obtained is insufficient. These cases are, unfortunately, of frequent occurrence. On the other hand, if the turbine is constructed to give off the required power under the reduced fall, it must be partially closed for the diminished water supply with the normal fall, whereby the efficiency would be reduced just when it should be highest, if economy is at all the chief object of a turbine plant. The manner in which a high efficiency can be maintained for a diminished water supply is to subdivide the turbine into several compartments, each of which represents a complete turbine. This arrangement has been adopted by Fourneyron for his well-known outward flow turbine, and in the modern Jonval turbine. The Fourneyron turbine is provided with a cylindrical gate, which is moved vertically, whereby each compartment is opened or closed. This type has been adopted for the large power plant on the Niagara Falls, but on the European continent it is seldom used. Their efficiency is very good, but owing to the narrowness of the buckets, they are easily choked.

The Jonval turbine is a parallel flow turbine, and is, for large variations of the fall and quantity of water, subdivided into two or more concentric compartments. A subdivision in this manner renders it possible to maintain not only the power, but also the speed, under a varying fall within very wide limits.

NIAGARA POWER FOR BUFFALO.

The Niagara Falls Power Company has ordered this month from the Westinghouse Company, of Pittsburg, seven dynamos to be used exclusively for the Buffalo transmisson. These machines will have a capacity of 5,000 horse-power each. Contracts were also given to E. D. Smith & Co., of Chicago, to build a power-house extension and wheel-pit for the dynamos. The officers announce that before summer closes power will be furnished to Buffalo.

POWER TRANSMISSION TO THE CITY OF MEXICO.

Manuel Fernandez Leal, Sec. Dep. Fomento, in behalf of the executive, is reported to have entered into a contract with W. Breckman, representing Siemens & Halske, of Chicago, Ill., for the transmission of water-power to the City of Mexico from the falls in the municipality of Tenancingo. The concessionnaires agree to utilize the hydraulic force produced by the falls of San Simon Atlocomulco and Achayatla for the purpose of generating and transmitting electrical energy to Mexico, the Federal district and neighboring States.

POWER TRANSMISSION AT CARACAS, VENEZUELA

Ricardo Zuloaga, of Caracas, Venezuela, has been at Niagara Falls with Mr. W. B. Wreaks, of the Westinghouse Electric and Manufacturing Company, to view the power installation there. Mr. Buloaga is a member of the Compania Anonima La Electricidad, of Caracas. This company has a project to develop power from two falls in the El Guaire River, the power to be transmitted to Caracas and used there. One of the falls under consideration has a height of about 120 feet and is expected to give 1,000 horse-power, while the other has a fall of 225 feet and will allow of the development of 2,000 horse-power.

POWER FROM LACHINE RAPIDS.

The Lachine Rapids of the St. Lawrence are at last to be utilized. For some time work has been prosecuted on a large wing dam that runs out for more than a thousand feet into the St. Lawrence river. A fall of water is secured by means of a dam sufficient to develop at the low water season about 15,000 horse-power. This water power is to be transformed into electricity.

Upon the dam a power house will be built that will run its entire length and show an unbroken interior of 1,000 feet in length. The basement of this will be occupied by Stilwell & Bierce water-wheels. The main floor will contain the dynamos, of which there will be twelve, each of 1,000 horse-power, or 12,000 horse-power in all.

They will generate current for transmission to Montreal, for use there in lighting the city, operating the street railroads and for any and all other lighting and power purposes.

ROENTGEN RAYS.

ROENTGEN-RAY EXPERIMENTS.[1]

BY DR. OLIVER J. LODGE.

IN the course of his experiments on Röntgen rays, Professor Oliver J. Lodge used a vacuum tube, which was made with three terminals, two aluminum cups facing each other, and one platinum disc at 45 degrees half way between them, with its terminal coming out at right angles to the other two, as shown in the illustration. The following results were obtained:

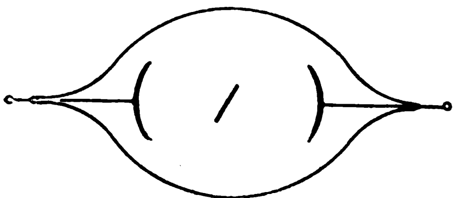
1. The cups being cathode and anode respectively, the insulated platinum disc acted as a moderately weak source, chiefly, of course, on the side facing the cathode. (The other side acts probably, only by reason of the partial transparency of platinum.)

2. The platinum being now connected to the cathode, its ray emitting power practically ceased.

3. The platinum being connected to the anode, it acted as a much more powerful source.

4. Connecting it to the anode through a Wimshurst machine in action, when the machine charged the disc positively it acted as a strong ray source; when the machine was reversed so as to charge the disc negatively it acted as only a very feeble source.

5. Shunting out the machine by short-circuiting its terminals, so as thereby to connect the disc direct to the anode, sometimes



LODGE'S X-RAY EXPERIMENTS.

improved, sometimes enfeebled, the action. With a low vacuum, such that the induction coil can readily discharge through the tube, the action is best without the Wimshurst; but with a high vacuum, such that the coil has a difficulty in discharging, the intervention of the continuous-action machine greatly improves matters.

6. If the machine is interposed between disc and cathode it does good only when it maintains a positive charge on the platinum disc.

7. Without the machine the coil usually acts best when connected so that one cup is cathode and the platinum disc sole anode, so that the charge is concentrated and not shared with any larger surface (though under extra high vacuum conditions a larger anode may become preferable).

8. The addition of the machine, between the disc and the other cup, may readily be made to strengthen the action still further.

9. It is desirable to force up and maintain the positive potential of the platinum disc in every way, e. g., by avoiding any brush discharge or other leak, and by putting the machine in series with the coil when the vacuum gets over high. The usual hasty hook mode of connection for low vacuum tubes is unsuitable for high vacuum tubes.

10. When the coil is connected to the two cups, and is in action, the insulated platinum disc in the middle becomes charged, so that a wire attached to it can emit minute sparks. The sign of this charge is, in my experience, always positive, no matter how the connection or current be reversed. Doubtless the cause of this is some brush discharge of negative electricity from other terminals; but whatever the cause, the effect is that the disc acquires the positive charge which appears necessary, and is certainly advantageous, to its action as an X-ray source, even when insulated, though, as previously said, it acts better if connected to or made the anode, or otherwise electrified strongly.

It has been asserted in France that although the X-rays are not ordinarily affected by a magnet, they will become so if passed through an electrified plate, thus acting like particles which could be first electrified and then magnetically deflected. Dr. Lodge tried a number of experiments in verification of this statement, but could find no evidence of its truth. No deflection or twisting of the X-rays could be observed, even after passing them through a highly electrified plate.

[1]Abstract from London "Electrican".

A THEORY OF X-RAYS.[1]

BY ALBERT A. MICHELSON.

THE principal facts, which any satisfactory theory of the X-rays is called upon to explain, may be summarized as follows:

(1) The production of the rays by electric impulse, at the cathode,[2] in a highly exhausted inclosure. (2) Propagation in straight lines and absence of interference, reflection, refraction and polarization. (3) The importance of density of the medium as the determining factor in the transmission of the rays. (4) The production of fluorescence and actinic effects, and the action on electrified conductors. Two theories have been proposed to account for these remarkable phenomena: (1) the theory of longitudinal waves; (2) the theory of projected particles. In reference to the first theory it may be said that unless it is proved that an oscillatory discharge is essential to the production of the X-rays, there can be no reason for supposing that these rays are of a periodic nature—that they are wave-motion, as commonly understood. The absence of interference, reflection and refraction is also a very formidable difficulty. Attempts have been made to account for the absence of these invariable accompaniments of every known form of wave-motion, but, as I think, with very indifferent success.

The most serious difficulty in the second theory is the attempt to explain the passage of the electrified particles of the residual gas (or of the electrode) through the walls of the vacuum tube. The query at once arises, if glass is permeable to those particles in virtue of their relatively great velocity, why is it not permeable (in lesser degree) to the same particles moving with smaller velocities? That it is not, is evident from the fact that vacuum tubes retain their high degree of exhaustion unimpaired for years.

In view of these difficulties, I would propose a third theory, which may be called the "ether-vortex" theory. Let it be supposed that the X-rays are vortices of an inter-molecular medium (provisionally, the ether[3]). These vortices are produced at the surface of the cathode, by the negative charge, which forces them out among the molecules of the cathode.

Let us now apply the tests above mentioned. According to this theory, an oscillatory discharge, while it may be just as effective as a series of separate impulses, is not essential to the formation of the vortices. The vortices being forced outward from the surface of the cathode by the negative charge, the effect of the positive charge at the anode would be to drive them in. Hence their appearance at the cathode alone.

One of the greatest puzzles connected with the behavior of the X-rays is the fact that while they can pass almost unimpeded through air at atmospheric pressure (let alone water, glass, wood, flesh, bone, and metals) when once outside the inclosure in which they are produced, they cannot even reach the walls of the inclosure, except there be a very high vacuum within. This problem receives a very natural solution if it be considered that, in order that ether-vortices may result from the electrical impulse, this impulse must be communicated to them; and must not be dissipated in the interchange of molecular charges which accompanies, or rather produces, the discharge at moderate or high pressures.

As exhaustion proceeds there are fewer molecules present to effect this discharge with sufficient rapidity, and as this limit is approached there will be a division of the energy of the electric impulse between the electrified molecules and the ether-vortices, and in the end all the energy of the discharge will be confined to the latter.

The reason for the non-appearance of the rays under ordinary conditions is not that the rays cannot reach the walls of the inclosure or pass through them, but that they cannot form at all. The propagation of vortices in straight lines, the absence of interference phenomena, of reflection, refraction and polarization, follow from the properties of vortices, and from the absence of anything corresponding to a wave front. The passage of an ether-vortex through a mass of matter may be compared with a passage of a smoke-ring through a wire gauze

[1] From the "American Journal of Science."

[2] Even should further experiment prove that the X-rays proper originate at the first obstruction encountered by the discharge, the fact remains that the discharge originates at the kathode.

[3] A possible objection occurs to the formation of ether-vortices in a medium which is usually considered free from viscosity; but the fact that vibrating molecules can and do communicate their motions to the surrounding ether shows that the communication of vortex motion may also be possible.

Though not a necessary part of the theory, it may be considered that the expulsion of the ether-vortices is due to an accumulation of ether in the kathode, and this would lend support to the theory that this accumulation is not merely a result of the negative charge, but that this excess of ether is what constitutes the negative charge.

screen or a series of such; and as the motion of the rings is more impeded the greater the diameter and the number of wires per unit volume, so, the greater the number and the size of the molecules—that is, the greater the density—the more effective will the medium be in dissipating the energy of the ether-vortices.

The production of fluorescence, actinic effects, and the dissipation of electric charges by light (which is an ether motion) would make it at least probable that similar (though perhaps not identical) effects would be produced by the motions of ether vortices.

Professor J. J. Thomson has measured the velocity of cathode rays and obtained a result so very far less than the velocity of light as to preclude entirely the idea of there being any connection between the two. If these results can be made to apply to the X-rays, the analogy with the properties of smoke-rings would lead us to expect such a result. The cathode rays have been shown by Lenard to have a considerable range in their properties, depending on the mode of their origin.[4] It seems likely that their velocities are to a considerable extent dependent on the potential and the suddenness of the electrical impulse; and if this were shown to be true of the X-rays, it would be to that extent a confirmation of the theory.

The foregoing evidence may be considered scarcely sufficient to entitle the proposition here advocated to the dignity of a theory, but it may at least merit consideration as a working hypothesis which may serve as a guide in future experiment.

THE SHAPE OF CROOKES TUBES AND DEGREE OF VACUUM FOR MAXIMUM PRODUCTION OF X-RAYS.[1]

EXPERIMENTS have been made by M. J. Chappuis, of Paris, to determine the actinic intensity of X-rays from Crookes tubes of different degrees of vacuum, the maximum being in the neighborhood of 1,1,000 of a millimetre for the tubes of pear shape as commonly employed. It was found that this maximum was not obtained with the same degree of vacuum in tubes whose forms were notably different.

Thus, with a cylindrical tube, such as that shown in Fig. 1, being 83 centimetres in length and having an interior diameter of 15 millimetres, and furnished at one end with a cathode plate, the following results were obtained:

P.	t.
0.025 mm.	30 sec.
0.012 "	25 "
0.010 "	14 "
0.0096 "	40 "
0.0058 "	75 "

The degree of vacuum pressure, P, was measured with a MacLeod gauge, and the time, t, which the electroscope took to discharge itself completely after being charged to a certain potential, was measured in seconds.

For the same degree of vacuum a pear-shaped tube showed

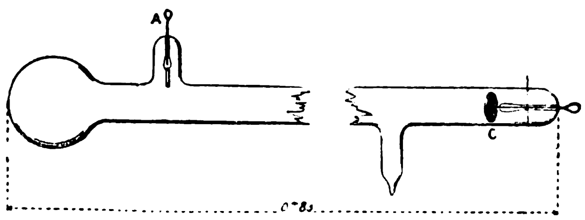


FIG. 1.

no sensible action on the electroscope. Its maximum was shown to be about 0.0011 mm., its action on the electroscope being then very intense. The discharge took place in a fraction of a second.

This particular form of tube whose length between the electrodes is 80 mm. and whose interior diameter is 15 mm., secures, for vacua relatively feeble, a fall of potential of the same order as that secured with the tubes in which the vacua are much higher.

If we adopt the hypothesis of molecular bombardment, the molecules of the residual gas would find themselves projected by the cathode with a velocity sufficient to be able to produce the emission of X-rays, and the form of the tube, in this case, would permit a larger number of molecules to participate efficiently in this action.

In attempting to utilize these results, the following tube, shown in Fig. 2, has been designed. It is made of a cylinder carrying at its right hand end a flat electrode, a circular electrode in the middle and at its left hand extremity a flat electrode, whose diameter is much larger than the principal tube. The object of this was to mask the entire diametrical section of this part of the apparatus. A swelling of 6 cm. in length formed the end of the tube behind the electrode, A. This design permits the use of A or B as the anode, C always being the cathode.

Experiments which have been made under these conditions lead to the conclusion that, to obtain the greatest production of

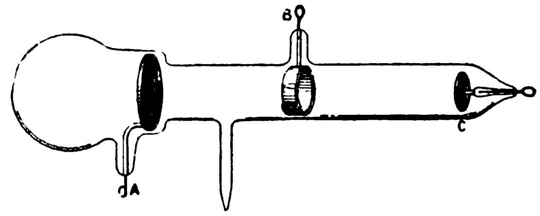


FIG. 2.

X-rays, the electrode C should constitute the cathode and the electrode A the anode. In this case no luminescence is produced in the swelling behind A.

Besides being superior for photographic work, this tube possesses other advantages over the ordinary pattern. Its life is much longer, and it permits of the reversal of the current without fear of alteration. The electrodes are all made of aluminum.

[4] The distinction between the X-rays and the cathode rays appears to be somewhat artificial, and it seems probable that the X-rays are only cathode rays sifted by the various media they have traversed.

[1] Communicated to the French Academy of Sciences.

PHOSPHORESCENCE AND X-RAYS IN THE GEISSLER AND CROOKES TUBES.

BY F. CAMPANILE AND E. STROMEI.

WE have communicated to the Acc. di Sc. fis. e mat. di Napoli (February 25th, 1896), that a spark introduced into the circuit of a Ruhmkorff coil and of a Crookes tube modifies the action of X-rays.

We call positive air spark the spark introduced between the positive pole and the tube, and negative air spark the spark introduced between the negative pole and the tube.

With rigorous experiments we have found that a positive air spark increases the effect of X-rays, and a negative air spark diminishes it. By means of various arrangements, we have also obtained the Crookes phosphorescence and the X-rays from the Geissler tube. The following arrangement (bipolar inductive) gives the best results:

On the outside of a Geissler tube are glued two pieces of tinfoil, which are connected to the poles of an induction coil. These are also in communication with a graduated sparkstand. When the coil acts, at every spark passing between the balls of the sparkstand, a discharge passes through the tube and illuminates it. Simultaneously on the wall opposite to the positive tinfoil appears the Crookes phosphorescence, which is accompanied by the X-rays. The Geissler tube in this side is transformed, monentarily, into a Crookes tube, whilst it maintains in the other regions the properties of the low vacuum tubes. In this arrangement the phosphorescence and the effect of the X-rays depend upon the length of the air-spark. There is a determined length, which produces the greatest action.

When it is unnecessary to employ Crookes tubes to obtain X-rays, the Röntgen phenomena may be produced by using low vacuum tubes without electrodes. Our arrangements are besides used to concentrate the cathodic rays, and consequently the phosphorescence and the X-rays, in a restricted side of a Crookes tube. The concentration was also obtained by employing a magnetic field.—London "Electrical Review."

STATUE OF BENJAMIN FRANKLIN UNVEILED IN CHICAGO.

A handsome bronze statue of Benjamin Franklin has been presented to the printers of Chicago by Joseph Medill, publisher of the Chicago "Tribune," and erected in Lincoln Park. About 3,000 persons were present at the presentation ceremony, the uncovering being done by Rene Bach, of Philadelphia, the great-great-grandson of Franklin.

The statue is the work of R. H. Park, the Chicago sculptor. The bronze figure is nine feet high and rests on a granite pedestal twelve feet high. It was presented by Mr. Medill in person, who made a brief address.

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CONTENTS.

RAPID TRANSIT IN NEW YORK.

THE cause of rapid transit in New York City does not appear to be making perceptible progress, in spite of the urgent and growing necessity for improvement in street railway facilities. The plans of the Rapid Transit Commission, including the part underground and part viaduct road from the Battery to Harlem, and operated by electricity, was generally considered an established undertaking until last month, when the Supreme Court of this State vetoed the proposition on purely economic grounds. Although $50,000,000 was the estimated cost of this undertaking it is not improbable that before such a road could be completed this amount might be considerably exceeded, and as this sum is greater than can be readily procured from private capital for an investment of this nature. New York City's only present alternative is to secure as great extensions and improvements of existing systems as possible.

Both the Manhattan Elevated and the Metropolitan and other surface car companies express themselves through the daily press as not only willing but eager to improve the facilities of their lines, but at the same time very little is done in this direction by any of them. For the last ten years these companies have been waiting for a perfect system of motive power and ever and anon they announce that they have found it; but nothing so far has resulted from these announcements, and while these companies are waiting for something to turn up, the public are standing packed solid in trains from the Battery to Harlem on the elevated roads, or taking an hour and a half to ride up on the horse or cable cars.

The elevated roads in New York are ideal roads for the employment of electric propulsion, and if this were to be adopted by them, in addition to the west side and crosstown extensions which have been proposed, it would do considerable towards relieving the excessive pressure of travel on these roads mornings and evenings. The constant growth of the city towards the north, however, makes it improbable that any possible development of the elevated roads along their present lines will be able to fulfill the demands of travel for more than a limited time. Owning their private roadbeds, as the elevated roads do, where no danger to the public could occur from contact with electric wires, the use of a voltage of double or more that of the surface roads could be made with perfect safety, thereby securing a very large economy in the first cost of copper conductors. Moreover the subject of electric propulsion is not in an experimental state, and several similar roads in this country are successfully operated by electricity, so the officers of the Manhattan system could easily assure themselves of the better service and greater economy of electricity if they desired to investigate the subject. Their policy, however, seems to be to wait until the change is imperatively demanded.

The surface roads of New York cannot be said to be making much better progress in the improvement of their facilities than the elevated roads have done, although a number of new methods of propulsion have been tried on various lines. The cable on Broadway, after a trial of some three years, is reported to be found wanting in several respects, and it seems pretty certain that but little more extension of this system will be made. The storage battery has been given a very limited trial on other lines, but without definite results. Three or four styles of conduit roads have been installed in different sections of the city and some objections have been raised against the Lenox avenue system, which is the most extensive open-conduit system tested in this city. The verdict on the other conduit lines remains to be found.

In the meanwhile a step backward is to be taken this summer, we understand, on the Madison avenue line, which is about to try compressed air. The superiority of electric propulsion to compressed air, both as to efficiency and economy, is so thoroughly understood among engineers that it scarcely seems probable that the Metropolitan company seriously considers compressed air as a commercial possibility. The sooner both

the public and the railway companies realise that electricity is far in advance of all other methods of propulsion and intelligent effort to adopt it is made, the sooner New York will be provided with those transit facilities, in which she is now outstripped by most of her smallest suburbs.

THE ECONOMY OF WATER POWER.

THE paper read before the Institution of Electrical Engineers by Mr. A. Steiger, on the Utilization of Water Power, and which is published elsewhere in this issue, serves to draw attention to the fact that the popular impression regarding the economy of water power is in very few cases actually realized in practice, or, at least the economy is not what it would appear to be considering the energy is supplied free of charge. It is almost impossible to make any general comparison between the cost of steam power supplied from coal and water power, although this is easily done in the case of any particular plant, but it is well known to engineers that, where coal is reasonably cheap, and the water power available needs considerable development, the former power is usually the more economical. Where natural conditions, on the other hand, are favorable, water power may offer great economy, but it is not by any means safe to assume this as a general rule.

The highest allowable cost of developing water power from the dam to the point of consumption is placed by good authorities at about $140 per horse-power, where the power is to be utilized on the basis of ten hours per day. One circumstance which greatly diminishes the economy of water power in a great many cases is the necessity frequently found of adding an auxiliary steam plant to the hydraulic plant in case of the failure of the latter during a dry season, and this auxiliary plant, however little it may be used, is always the source of more or less expense to keep it in repair, and in condition to be put in service at any time.

Dr. C. E. Emery places the average annual charges against a hydraulic plant at 17 per cent. and at an original cost of $140 per horse-power, this would bring the cost of a horse-power per year up to $23.80, which is within the limit of attainment with the most economical types of steam engine and with coal at a moderate price. If the power is to be transmitted to a distance the cost of an electrical transmission plant must be included in the estimate of developing the hydraulic plant, so that while water power in some cases may prove very economical, it is not safe to assume it to be so without a very careful examination of the local conditions.

WESTERN UNION AND AMERICAN BELL.

THE formation of a company with a capital of $16,000,000 to operate telephone lines in the States of New York, Massachusetts, Rhode Island, Connecticut and New Jersey, in which officers of the American Bell and Western Union companies are represented, serves to call attention to the approaching expiration of the agreement between these two companies and their probable future relations. The agreement of 1879, which was published in full in The Electrical Engineer of August 28, 1895, expires on August 26, 1896, and with it the restrictions which have heretofore been a bar to the Bell company's entering the telegraphic field, and, on the other hand, prevented the Western Union from doing a telephone business. As a matter of fact, it is an open secret that the Bell company, through its licensee, the "Long Distance" company has for some time past done a telegraph business, consisting in the leasing of private wires to bankers and brokers. So serious had this become that an open rupture with the Western Union was barely averted and it is asserted that the latter company was only pacified by the payment of a handsome indemnity for its lost business. That a closer rapprochement between the two companies is on the tapis is probably true, but it is doubtful whether the company organized last week at Albany is intended as a step in that direction. We look upon it more in the light of a consolidation of the telephone interests centering in New York, including the Metropolitan company, and those companies which have close business connections with it through extra territorial lines. That the Western Union officers should be represented in the list of organizers is not strange, in view of the fact that that company owns 40 per cent. of the stock of the Metropolitan company, and the Bell company's representation is also easily explained on similar grounds of stock participation in the same company.

ELECTRIC METERS.

AT the recent meeting of the Western Gas Association, considerable discussion was heard on the subject of the method of charging customers for electric lighting, and as the electric light plants which are run as auxiliaries to gas plants are generally of rather small capacities, it seems still to be an open question with most of these stations whether to charge for current on a flat rate or upon a meter basis. The advocates of flat rates, who seemed to be in the majority among the gas men, based their arguments very largely upon their unsatisfactory experiences with different kinds of electric meters, and the discussion revealed the fact that these instruments are held in rather low estimation by gas men, as well as by the public generally.

The difficulties between the lighting companies and the consumers when the charge for current is made on the basis of a flat rate are numerous and, as a rule, unavoidable, yet it is difficult to convince the stockholders of a company to abandon flat rates and install meters when they regard these instruments only as an additional expense which secures no more profit to the company that is obtained under the flat rate. It is safe to say, however, that it will soon be impossible for lighting stations to supply current on any other than a meter basis, as the flat rate is not only undesirable on account of the carelessness, or even dishonesty, on the part of customers, but because of the very great difference in the quality of the lamps now on the market in regard to the watts consumed per candle-power. As between two lamps of different efficiencies, the customer who burns the one of lowest efficiency uses more current than one burning high efficiency lamps without obtaining any better light, and as there is no standard of efficiency, one customer may be paying on a flat rate for the same amount of light as another and yet using a lamp that may cost the station 50 per cent. more to feed.

Another point brought out during the discussion was the impossibility of knowing the amount of leakage on the system between the station and the customer without the use of meters; or, in other words, how much current has been sold during the month and how much remains unaccounted for.

The electric central station business was never settled upon a sound basis until the meter system was adopted, and it will eventually be found by the gas men that meters are just as much of a necessity in the electrical branch of their business as they are in the supply of gas.

THE WALKER CO. INDEPENDENT.

SINCE the recent consolidation of the interests between the General Electric Company and the Westinghouse Company rumors have been rife of attempts at, and even of consummation of, working arrangements between the former and other large electric companies. The most persistent of these refers to the absorption of the Walker Company by the combination, as noted in another column. This action, though attempted, has not been consummated, and we are definitely informed that it will not be, and that, on the contrary, the Walker Company will make a strong and active competitor to the trust. This determination on the part of the Walker Company to stand on its own bottom is only another indication of the oft-expressed belief that no one concern can, or ever will, control the electrical industry of the United States. Besides the Walker Company, there are in the field other strong concerns, both large and small, who may be depended upon to carry on active competition, and to give that stimulus to the trade without which improvement and progress would come to a standstill.

PROGRESS BY LEAPS.

A BRIEF glance at what electricity has done points to the fact that no other of the arts and sciences has had such an effect on the progress of mankind. As Mr. George Iles in the "Popular Science Monthly" for June states, the subjugation of electricity means for thought and work not merely an addition, but a multiplier. In tracing the numerous interconnections of electrical science and art with other sciences and arts an increase in progress is shown similar to a series of permutations, where each new discovery, like a factor, multiplies all that has gone before. In less than a hundred years the current first liberated from Volta's crown of cups has interwoven itself with every art and science, and comparing this rapid conquest with the slow progress of other sciences for ages past, illustrates the vast expansion of human progress with each new discovery in and adaptation of electricity.

MISCELLANEOUS.

INCREASING THE STRIKING DISTANCE AT A GIVEN E. M. F.

BY ELIHU THOMSON.

I NOTICE on pages 613, 614 and 615 of your issue of June 19 a description of a phenomenon under the head "Method of Increasing the Striking Distance at a Given E. M. F.," described by Mr. Skinner, and credited to him as a discovery by Mr. A. J. Wurts. While the experiments detailed and the extensions of them are decidedly interesting, I wish to state that the basic phenomenon or method of increasing the striking distance described is by no means new. I have known and practiced the method on occasion for at least thirty years, and I have no doubt that others have been familiar with the effect.

I originally used it when about 13 years old, to increase the spark of a Leyden jar. This I did by taking a straight limb discharging rod and slipping a test tube over the end, having first removed the ball from the limb of the discharger. The round end of the test tube was presented to the ball connected with the interior coating of the jar and the uncovered limb to the external coating, while the test tube lay on the upper limb of the discharger, said upper limb being covered for a considerable portion of its length by the test tube. In this case a discharge which would have jumped, say, one-half an inch in air was easily caused to pass over three inches, the length of the test tube.

I have frequently exhibited the phenomenon in lectures from time to time, sometimes pasting a strip of tinfoil on the interior of a glass tube from one end to the other and allowing the spark to jump to the closed end, in which case it would follow the tinfoil in passing over the exterior. A spark of a few inches would in this way be extended to make a visible stream of fire of a foot or more.

I may further remark, as showing clearly that the experiment is very old, that the old frictional plate machines used before the days of the Holtz machine and its modifications, were often provided with a silvered glass ball on the prime conductor, the silvering being done inside the ball. These balls were sometimes six or eight inches in diameter. Their purpose was to increase the capacity or extent of outside surface, so to speak, of the prime conductor, and thereby to thicken the spark obtained in discharging the same. Experimenters were accustomed to take sparks sometimes from the ball itself, in which case it was frequently noted that the spark would travel many inches over the glass surface from the neck of the ball to the point of the application of the knuckle or other discharging body, its ability to so pass over the outer glass surface being, of course, due to the inner coating of silver.

Another way of extending the spark which I used, based on the method described, was to smoke a piece of glass and then cause the discharge to pass over the surface. In this case the spark was greatly lengthened and it passed, of course, over the soot particles, at the same time making a clear space or tracing which tracing could be examined afterward with a magnifying glass and the explosive action of the spark distinctly seen.

In making these statements, I do not, of course, intend to discourage the work of experiment in this direction and the application of the results of the same to useful ends, but merely to correct what is evidently a misconception of the history of the science.

ELECTROLYTIC MANUFACTURE OF WHITE LEAD.

R. P. Williams (J. Am. Chem. Soc. 17, 835-842) describes the patent process of A. B. Brown for the electrolytic production of white lead. It consists in decomposing, by an electric current, a solution of sodium nitrate, containing about 1 lb. to the gallon, in wood cells provided with porous diaphragms; the nitric acid radical attacks the positive electrode, which is of metallic lead, and the lead nitrate solution thus formed is precipitated later by the sodium hydrate produced at the other electrode. The precipitated lead hydroxide is digested with bicarbonate of soda solution, whereby lead carbonate in a very fine state of division is obtained. The sodium nitrate is thereby regenerated. The sodium bicarbonate used is formed by passing carbon dioxide into the caustic soda solution. It is claimed that the process can be made a commercial success, the white lead being equal or superior to that made by the old "Dutch process." The plant required is small for a considerable output, and there is no loss of time, the reactions taking place rapidly. There is a great saving in labor and materials as compared with the Dutch process. The product of the electrolytic process is in a very fine state of division, and is claimed to be of a spongy character, non-crystalline, and having a greater covering power than Dutch process lead. Tests of durability show this lead to be fully equal to Dutch lead.

THE PRACTICAL TESTING OF IRON AND STEEL FOR MAGNETIC QUALITY.[1]

BY W. K. HOWE.

THE investigation of the magnetic properties of iron and steel is a very interesting pursuit and of undisputed value in the scientific world. But I have been led to the belief that a question has arisen in the minds of some as to the extent of its value in practice. Does the gain pay for the necessary expense and time for properly carrying on such tests, or is it merely an expensive luxury?

In reply to these questions, and without attempting to claim too much, I will say that testing, although not essential, undoubtedly leads to economy. It is not essential principally because it is possible to manufacture dynamo electric machinery and sell it at a profit without specific knowledge of the magnetic quality of the material used, providing you have a general knowledge of like material, such, for example, as is given by Hopkinson, Kapp and others.

Although it is possible thus to build electrical machinery, the probabilities are that it will not be well proportioned. To be sure, if a dynamo does not come out to figures, you can add to or take off wire from the fields, as the case may be, or else the speed may be increased or diminished or something else resorted to, but even after your machine has been brought, by this expensive "cut and try" method, to the proper working condition, you are not, even then, sure where the fault lies.

It may be you have used a wrong leakage coefficient, or perhaps the iron is not what you expected. The yoke may be too heavy and the magnet cores too small, or there may be more armature iron than necessary, and how are you going to find out where the trouble is? One way would be to vary the different parts one at a time and watch the effect of each change, but this would involve a great expense for machine work, etc. Another, and by far the most satisfactory way, would be to determine, as nearly as possible, the leakage coefficients beforehand and then with the previously obtained knowledge of the magnetic quality of the iron to be used, design the machine, predetermining the exact windings and proportions.

Upon testing the machine, if it does not come out to figures and if you are assured that the mechanical dimensions, winding, etc., are according to specifications, you know it is due to wrong leakage coefficients which can now be accurately determined.

Therefore, I name, as one benefit to be derived from careful testing, the power it gives one to largely predetermine the proportions of a dynamo, thus avoiding a great deal of the expensive changing which is often necessary with the "cut and try" method.

Another advantage is when there are several points of uncertainty in a dynamo, for example, the leakage coefficients, it is quite helpful in unraveling the mystery to have at least one thing definite to fall back upon. The value of testing in connection with transformer work is perhaps even greater than in building dynamos, for if a transformer is built of poor iron no change in windings or in the amount of iron will make it good. In connection with foundry work a testing instrument is of great value, especially when used in connection with chemical analysis, for it enables the foundryman to tell what mixtures and treatment will give the best results. Its advantage in purchasing metal and keeping a check on it as it is delivered is self-evident. In short, I can think of no better comparison than to liken the man with facilities for testing to one who walks with his eyes open, and the one without to the man that proceeds with them shut.

Hoping the benefits thus named are sufficient to convince any who may be sceptical that there are decided advantages to be derived from testing, let us turn to the question of the selection of samples.

No matter how eleborate the instrument or how accurately the magnetic quality may be determined, if the sample thus tested is not like the metal whose quality you are trying to determine, of what value is the best? One would suppose, on first thought, that the selection of a representative test bar would be an easy matter, but the reverse is often true. In fact, it requires no little care and experience, since there are so many conditions which affect the permeability. Some of them are as follows: The rate of cooling should be regulated, for if a test bar should be cast by itself, it would be sure to cool faster and consequently have a lower permeability than if it were allowed to cool slowly. In a case of this kind it would

[1] Read before the Chicago Electrical Association.

be well to cast the bar in close proximity to the casting itself so that the heat from the large mass will keep the sample warm. If a bar is to be cut from a casting it should be remembered that the metal at the bottom is usually the best; that in the middle the poorest, and that on the top somewhere between the bottom and center, so that the sample in this case should be taken from somewhere near the top, referring to the way it was cast.

To determine this pòint more accurately it would be well to

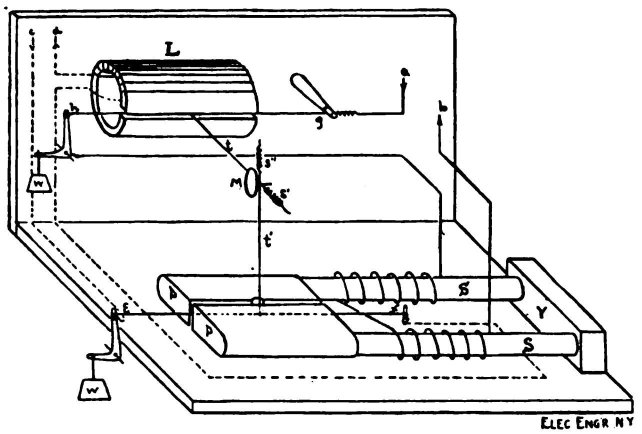


FIG. 1.—EWING'S MAGNETIC CURVE TRACER.

have, say, three bars, cut from different parts of the casting, testing each, and repeating the process a few times with different castings until sure of the locality that will give a sample of average value.

If it is desired to test a heat from a cupola it will not do to take a sample at random from any part of it, because the quality varies at different stages, and while I can give no definite information as to where the best metal is taken off, I can suggest a simple way to find out, and that is, to do the same as was suggested in connection with the large casting, namely, take off samples at different stages, being sure to cast them all in the same position and have them cool equally.

Sheet iron and sheet steel samples should be composed of a number of pieces of the proper shape taken from various parts of the lot, and not all from the same sheet, since the quality of one is not necessarily representative of all.

Of the samples sent in from outside concerns one can have but a limited knowledge of the way in which they were prepared; therefore, it is not safe to consider such tests as final, but using them as a guide a small dynamo frame should be cast to see if its permeability compares with the sample.

Since annealing has a very beneficial effect in increasing permeability, it is well, in comparing a number of samples, about the preparation of which you have no knowledge, to reduce them, as it were, to a common level by annealing them all under exactly the same conditions. If any have been previously annealed they will not improve much, but if they have not been their permeability will increase considerably.

Having selected a representative sample, the next thing that confronts the investigator is the method to be used in testing it. Since commercial tests to be of the greatest possible value must be made accurately and often, and since the bulk of the work need only be comparisons, absolute determinations being but seldom necessary, an instrument for the purpose should possess the following points:

1. It must give reliable results at all times and not depend for its action upon parts which are liable to get out of adjustment, unless such deviations can be detected and readily readjusted, or upon parts which are particularly susceptible to local magnetic influences or vibrations.

3. The form of the sample should be as simple as possible, allowing it to be quickly and cheaply made.

3. It should permit of rapid comparative tests and of calibration for absolute measurements.

4. It should be direct reading if possible, requiring no laborious corrections or calculations to get the result.

5. It should, if possible, be capable of testing both solid bars and sheet, either for hysteresis or permeability, even though other and more important qualities have to be sacrificed; for this it is better to have a special instrument for each purpose.

A number of instruments are in use at the present time, which fulfill many, if not all, of the conditions just named, but before describing those of the greatest value in practice I wish, for the sake of illustration and comparison, to mention a method which, although highly scientific and perhaps the only practical method of making original determinations, is not good for testing such as is carried on in connection with the building of dynamo electric machinery.

It is the old and well-known ballistic method, descriptions of which may be found in Ewing's work on magnetism, in Thompson's dynamo electric machinery, and a number of other works on magnetism and electricity. It depends for its operation upon the transient current induced in a secondary coil, wound around the sample, when the primary current is suddenly increased, decreased, or reversed. This induced current is proportional to the whole change of induction resulting from such change.

The instrument used to record the impulses of the transient current is called a ballistic galvanometer and is simply an ordinary galvanometer, having a weight attached to the needle to give it a large moment of inertia, compared with the directive force acting upon it. This permits practically the whole quantity of the transient current to pass before the needle has stirred, sensibly, from its position of rest. Perhaps the greatest advantage of this method is that it is possible to have the metal composing the sample in the form of a continuous ring, no doubtful corrections having to be made for foreign substances in magnetic circuit with the sample, such as air gaps or other pieces of iron, as will be noticed in subsequent instruments to be described. Another advantage arising from the ring form of sample is that the induction is uniform at all points and the magnetic circuit of positive length. The disadvantages of this method are due mainly to the galvanometer, since it is very sensitive to vibration, and it takes a long time to make a proper test.

Returning now to the instruments of a more practical character, I have illustrated in Fig. 1, the form of instrument designed by Professor J. A. Ewing and called a magnetic curve tracer.

The principle used is that whenever a wire carrying a current is placed in a megnetic field it will tend to move in a direction at right angles to the lines of force either one way or the other, depending upon the relative direction of the current and the lines of force. The force acting upon the wire is proportional to the product of the flux and current.

The instrument is constructed as follows: The specimens, S S, of which there must be two, are joined at one end by the yoke, Y, the other ends terminating in pole pieces, P P. In the instrument as actually constructed, the pole pieces have clamps that serve to hold the specimen.

Between the poles P P is a narrow slit, in which is stretched a wire, e f, that is kept under tension by a weight, W, acting through the medium of the bell crank lever, e. Above, to the left and parallel with the pole pieces, is a long C-shaped magnet, L, which also has a slit which runs parallel to the one between the poles. In this slit is stretched another wire, g h, which is kept tight in the same manner as the one between the poles, P P. Any lateral movement of these wires is comunicated, by the threads t and t' to a tiny mirror, M, which is free to deflect in any direction. The wires, g h and e f, are kept under slight tension by the springs, s' and s", respectively, and, when there are no other forces acting, these springs should bring the mirror to zero position. A tiny spot of light is thrown upon this morror and thus any movement of the wires, how-

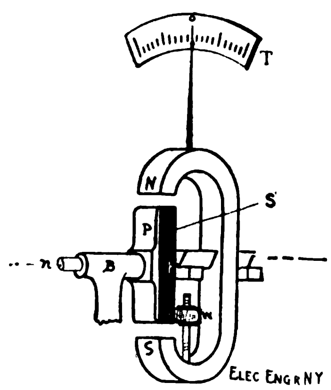


FIG. 2.—EWING'S MAGNETIC TESTER.

ever slight, is easily detected and measured by the movement of the spot of light upon a screen set up for the purpose.

In the circuit a and b is included the wire g h, the magnetizing coil around the specimens and also a rheostat (not shown) for varying the current. The circuit c d (dotted for sake of clearness) includes the wire e f and the C-shaped electro magnet, L. The current in this circuit is kept at some constant value.

Since the current flowing in g h is the same as that producing

the magnetomotive force, H, and since this wire is in a magnetic field of constant strength, its movement will be proportional to H, and since the flux across the slit between the pole pieces is directly proportional to the density, B, in the specimens, the movement of the wire e f carrying a constant current, will be proportional to B.

If the wire e f is cut out of service for a moment the wire g h will cause the spot of light to trace a horizontal straight line

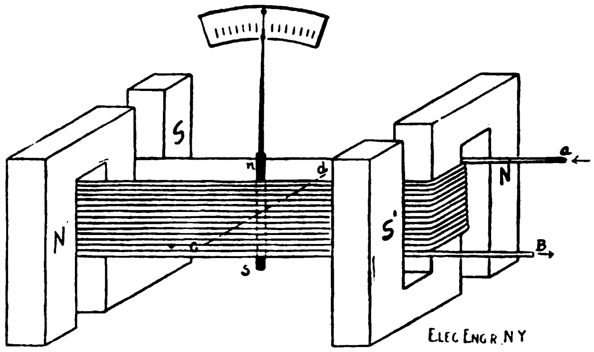


Fig. 3.—Eickemeyer's Differential Magnetometer.

on the screen which we will call the H axis. Likewise if the wire g h is made inoperative for a short time e f will trace a verticle straight line which will be the B axis.

The resultant deflection of the mirror, due to the action of the wires, will place the spot of light in such a position that its horizontal distance from the B axis will represent H, and its vertical distance from the H axis will represent B, so that by carrying the magnetizing force from zero up to full value, the curve of permeability will be traced and by carrying it through a complete cycle the hysteresis loop will result.

With this instrument samples may be rapidly compared, and if the permeability of one has been previously determined, the absolute value of any of them can be found by proportion. Slight variations in the adjustment of the instrument from time to time will make no difference, since they will affect the curves of the standard sample in the same proportion as those of the samples under test. One of the advantages peculiar to this form of instrument is that the moment of inertia of the moving parts is so light that rapid cyclic variations of the magnetizing force may be carried through and the corresponding hysteresis cycle observed since the spot of light in moving so rapidly traces a continuous curve. In calculating the mag-

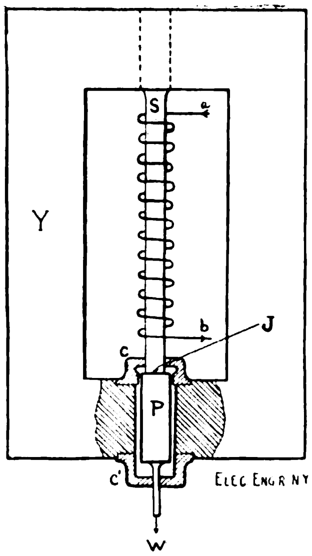


Fig. 4.

netomotive force required to drive the flux through the samples alone a correction must be made, for the force used up in driving it through the yoke, pole pieces and air gap. In regular testing the spot of light is made to travel over a sheet of paper put up in place of the screen and its successive positions marked with a lead pencil.

In Fig. 2 is shown another instrument designed by Ewing for measuring hysteresis. It consists of a permanent magnet, N S, pivoted on a knife edge. Between its poles is rotated the specimen S'. The work lost in reversing the magnetism in the specimen rotates the magnet sidewise against the force of gravity. Since the deflection is proportional to the work thus lost it affords a ready means for comparing the hysteresis of different samples. The deflection is indicated by the pointer on top of the magnet which plays over a scale, T, and the instrument is made more or less sensitive by moving the weight, W, up or down.

The samples are very easy to prepare, consisting of a few simple rectangular strips 3 inches long by ⅝ inch wide, which are filed to the exact length in a gauge furnished with the instrument. Since sheet metal comes in various thicknesses, it is best to use a definite weight of material for the sample.

The air gaps between the sample and magnet are quite long and consequently offer an enormously greater reluctance to the passage of the lines of force than the sample, so that if different samples should offer different reluctances, these differnces would be such a small percentage of the total reluctance that the indication will be practically tne same for all samples, a condition that is of prime importance in making comparisons with this instrument. Of course the induction produced by a permanent magnet is relatively small, but this makes very little difference, since it is a pretty well established fact that the hysteresis varies in all samples in about the same proportion. Standard samples of known quality are sent with each instrument, so that one can tell by comparison tne actual loss in his sample.

The same is rotated oy hand through the medium of a large

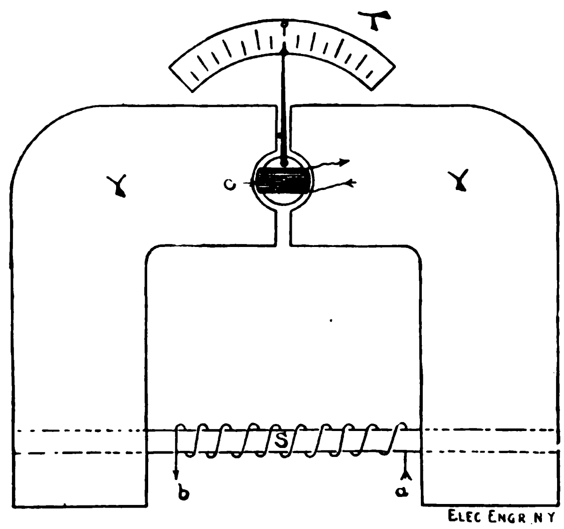


Fig. 5.

friction wheel, which bears against a small one on the shaft n that carries the sample. The speed of rotation is a matter of no particular importance, provided it is not so slow that the readings are unsteady. This is true because the work required to carry the magnetism through a complete cycle is the same, as far as hysteresis is concerned, no matter how rapidly it is done, and although it requires more power to turn the sample rapidly, its drag on the magnet is no greater unless it be that the fanning action of the sample and the eddy currents have an effect. If they do it will be shown by a gradual increase of the readings as the speed is increased. The preparation of samples is so inexpensive and the operation so rapid and simple that it makes it an admirable instrument for practical work.

In Fig. 3 is shown the Eickemeyer differential magnetometer. It is a zero instrument, the principle involved being that of the differential galvanometer, in which the same current is made to flow in opposite directions through equal coils ,which are in series and situated symmetrically with respect to a polarized needle. The coils having equal and opposite effects upon the needle, it remains in zero position unless one of the coils is shunted by a resistance. In this event the other must be equally shunted to bring the needle to zero again.

This method of comparing two resistances is employed in the differential magnetometer, as follows: Two heavy S-shaped pieces of Norway iron are placed parallel with each other, as shown in the figure, so that their front and back faces are in the same plane, respectively.

Around the central portions of these pieces is wound a magnetizing coil, A B, which magnetizes the soft iron needle, N S, and causes it to point to zero on the scale. This magnetizing coil also causes lines of force to flow from N to S on the

back and from N to S on the front of the instrument, but they have no effect on the needle since the flux is equal and opposite. However, if the air path, N S, is shunted by laying a piece of iron against the back of the pole pieces some of the lines which previously passed through the air will now flow through the iron and their different effect removed from the needle and it will deflect to the right, due to the excess of free lines flowing from N to S.

In order to restore the needle to zero a piece of iron of equal reluctance must be laid against the front pole pieces. Now suppose that the piece of iron laid against the back of the pole pieces was a sample of unknown value and that the piece on the front is iron of known permeability, it is quite evident that the permeability can be found by the ratio between the cross sections of the two. If the sections are equal the permeability is the same. If the standard bar is of greater section the same is better, and vice versa.

The standard bar, instead of being solid, is divided into a number of strips for facility in altering its section. If no combination of these strips can be found that will give a zero reading, the current in the magnetizing coil can be changed a little to make it come right. Closely surrounding the needle is a small coil, not shown, which, when excited in an opposite direction to that of the magnetizing coil, reduces its directive force, making the instrument more or less sensitive.

In Fig. 4 is shown an instrument originally designed by S. P. Thompson and recently modified by Kapp. The underlying principle is the law of attraction, namely, that the force required to pull apart two pieces of iron which are magnetized varies, as the square of the induction and the area of contact.

The construction of the instrument is as follows: The specimen, S, is firmly held in the top part of a massive soft iron yoke, Y; the lower end terminating at J is faced off truly and is held central by the brass collar, C. Below the specimen is a small soft iron plunger, P, which is guided at its upper and lower ends. Its upper end is faced true and is held against the lower end of the specimen by magnetic attraction. At its lower end is fastened a scale pan, W, for receiving weights.

Its operation is as follows: A certain measured current is sent through the magnetizing coil, a b, and then weights are added until the plunger is pulled off. From the area of contact at J and the total weight of plunger, scale pan and weights, the induction is calculated by the following simple formula:

Let $B =$ the induction per square centimetre;
Let $A =$ the cross-section of the specimen in square centimetres;
Let $W =$ the weight in pounds.

$$\text{Then } B = 3{,}345\sqrt{\frac{W}{A}}.$$

To find H, let M be the total ampere turns in the coil, a b. Let N be the ampere turns required to drive the flux through the plunger, air gap and yokes, found by calculation from the known dimensions of the instrument or by experiment, in a way to be explained later, and let L be the length of the sample in centimeters from the yoke down to the contact J.

$$\text{Then } H = \frac{M-N}{L} \times \frac{10}{4\pi}.$$

These calculations may be greatly simplified in practice by plotting a curve of B and the corresponding pounds pull, using some standard section for the sample. From this curve the value of B can be taken directly when the tearing off weight is known. Furthermore, a curve may be plotted with W as ordinates and N as abscissae from which the number of ampere turns for the yoke, air gap and plunger corresponding to any weight may be taken directly and thus H found more easily. If it is desired to obtain the magnetizing force for the frame more accurately than is possible by calculation, a sample of known permeability can be tested and its curve plotted to the same scale and on the same sheet with the known B H curve of the sample. The horizontal distance between the two curves at any value of B will give a value from which the magnetizing force expended in the frame may be absolutely determined.

In Fig. 5 is shown an instrument for making either permeability or hysteresis tests, suggested by Mr. L. T. Robinson. It is constructed as follows: The specimen S is held, by suitable clamps in the two massive pole pieces, Y Y, which embrace a cylindrical armature of soft iron, around which is wound a fine wire coil, C, in a longitudinal direction. The magnetic flux across the gap between the pole pieces is proportional to the induction in the sample produced by the magnetizing coil, a b. The rotative force brought to bear upon the cylindrical armature, when there is a constant current flowing in the coil, C, is proportional to B. This force acts against a coiled spring so that for any given induction the pointer will stand at a definite place on the scale. The instrument may be calibrated by using a sample bar of known permeability, as in some of the other instruments which I have described. One of the advantages of this form of instrument, as in Ewing's curve tracer, is that B may be read directly. H, however, has to be calculated by subtracting the ampere turns for the frame and air gap from the total, as described in connection with Fig. 4.

Several other ingenious and practical methods for testing iron and steel have appeared in the electrical papers from time to time, among which is one described by Mr. Frank Holden, and used at the works of the General Electric Company. It is used for measuring hysteresis and eddy current losses and consists of a revolving electro magnet, between the poles of which is pivoted the specimen to be tested, consisting of a number of rings built up similar to the core of a ring armature. The work lost in reversing the magnetism in the specimen tends to rotate the armature against the action of a coiled spring and a pointer, which moves over a graduated scale, registers the amount of work lost. A stationary coil held between the armature and pole pieces, but not touching either, gives a voltage proportional to the flux passing through the armature. This instrument is much like Ewing's magnetic tester, Fig. 2, except that the induction can be varied and measured and also the magnets revolved instead of the specimen. It is of value not only in testing for hysteresis, but enables one to decide upon the proper thickness and insulation of the sheets used in armatures and transformers.

Having mentioned, in connection with the instruments just described, the need of a standard sample of known permeability, I suggest the following way of obtaining one: Have two samples prepared, of exactly the same material, one in the form of a ring and the other to fit your instrument. A test of the ring by the ballistic method will give the B-H curves of both samples. Assuming that there will be those who desire further information regarding the instruments, I have described, and wishing to acknowledge my indebtedness to certain articles which have appeared from time to time, I take pleasure in referring to them.

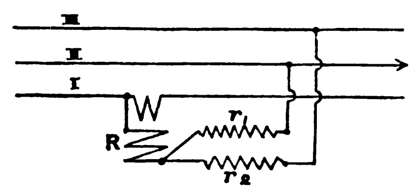
Professor Ewing's magnetic curve tracer (Fig. 1) is described by himself in The Electrical Engineer, June 21, 1893, and also in a current number of the London "Electrician." The magnetic tester (Fig. 2) is described in the London "Electrician" and "Electrical Engineer" in April and May, 1895.

The differential magnetometer (Fig. 3) is well described by Mr. Steinmetz in The Electrical Engineer, March 25, 1891. The instrument shown in Fig. 4, and also a method for measuring hysteresis, is described in the London "Electrical Engineer," February 23, and March 2, 1894, by Kapp. Mr. L. T. Robinson describes the form shown in Fig. 5 in "Electrical World," February 24, 1894. Mr. Frank Holden gives a description of his instrument for measuring hysteresis, etc., in the "Electrical World," June 15, 1895. Other articles of interest on the subject of iron testing will be found in The Electrical Engineer, April 9, 1890, and July 13, 1892, and in the "Electrical World," June 8, 1895. In the fourth edition of Thompson's Dynamo Electric Machinery and in Ewing's book on magnetism will be found descriptions of other methods which I have not mentioned.

MEASUREMENT OF THE POWER OF TRIPHASE CURRENTS.

DR. BEHN-ESCHENBURG describes a very simple method of measuring the power transmitted by the three conductors of a triphased system, in the "Electrotechnische Zeitschrift."

It is generally known that when we are at some distance from the neutral point, or when this point is not accessible or does not exist (triangular winding), and when the current is not



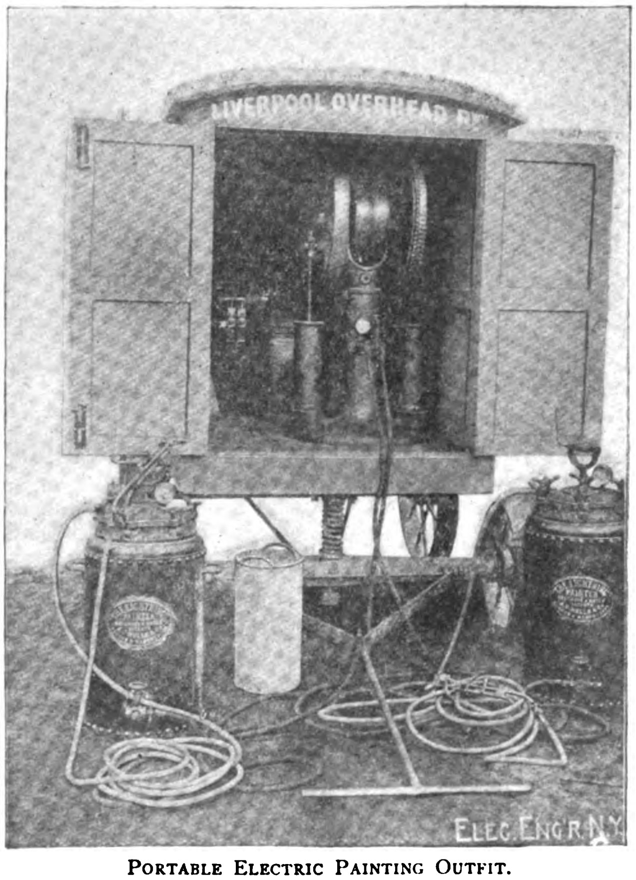
MEASURING POWER OF TRIPHASE CURRENTS.

equal in the three branches, the measurement of the power by the aid of an ordinary wattmeter may present some difficulties especially if there is no compensating wire. There is, however, a means of arriving quickly at the result by using an ordinary Siemens or Ganz wattmeter, or even, which is still more practical, a Siemens electro-dynamometer branched like a wattmeter. It is, however, necessary that the resistance, R,

of the coil of the apparatus in parallel should be small in comparison with the non-inductive one which is to be placed in series with it. We use two equal auxiliary resistances, r_1 and r_2, placed in parallel on the movable coil and connected to two different principal conductors, the other extremity of the coil being branched on the third principal conductor, as shown in the accompanying figure. The current circulating in this third conductor passes through the fixed coil of the wattmeter. The effects of this combination are as follows: The current passing through the movable coil is equal to the sum of the currents passing through the resistances, r_1 and r_2, which are in proportion and correspond in phase to the difference of potential between their respective conductors. The indication of the wattmeter, therefore, gives directly the measurement of the total power of the triphased currents, although the charge of the branches is unequal. In this method, we substitute the total effect for the separate effects of the two coils in parallel, which might be determined successively by two different measurements according to the old method, by using first one of the branches and then the other.

PORTABLE ELECTRIC PAINTING PLANT FOR THE LIVERPOOL OVERHEAD RAILWAY.

ONE of the minor but by no means small advantages of an electric system of traction is the existence along the line of power which can be used for driving portable repairing and painting machinery. In any trolley system, or where there is a continuous supply of power by surface conductor rails, as in the City and South London Railway, and the Liverpool Overhead Railway, or again in conduit systems, it is not at all difficult to run an electrically-driven repairing tool by means of power derived by tapping the main power conductor at any convenient point. Thus repairs may be performed more quickly



PORTABLE ELECTRIC PAINTING OUTFIT.

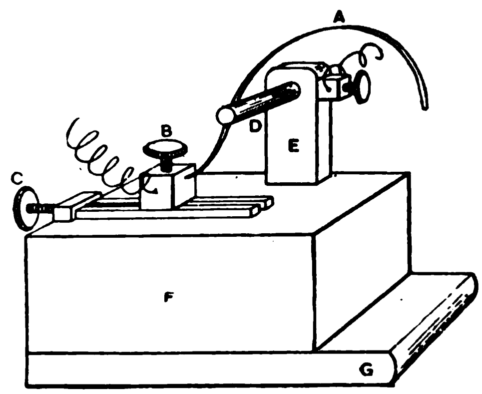
and cheaply than by hand, and heavier repairs than could be done without the aid of motor power can be performed in situ.

The latest example of this use of electric power is to be found in a portable painting plant, which has been built by Messrs. A. C. Wells & Co., of London and Manchester, for the Liverpool Overhead Railway. The accompanying illustration has been prepared from a photograph of this plant. Within the car which has been specially built for this painting machine is an electric motor, coupled to the force pump of a Wallwork & Wells spraying painter, together with the paint reservoirs, hose and auxiliary details. This car can be run on the tramway which lies immediately beneath the overhead track of the electric railway, and by means of flexible cables power can be obtained from the surface conductor on the electric line above. By this means the whole of the entensive girder work on which the electric railway is carried can be covered by the paint spray. Hitherto some forty hands have been required for painting these girders, and there is little doubt that great economy of time and labor will be effected by the new arrangement. The spraying method, we should mention, is not only used for painting extensive surfaces with a uniform color, but also by the aid of stencil plates, it is adopted for painting letters and ornamental work.—London "Electrician."

AN ELECTRICAL TREVELYAN ROCKER.[1]

BY T. A. VAUGHTON.

THE following account of what appears to be a new electrical phenomenon which I have been investigating will probably be of interest to the readers of "The Electrician." In making these investigations, I have used an apparatus, of which the accompanying illustration shows the general form, which I have manufactured in the following manner: A piece of watch-spring, A, curved into the shape shown, is fixed into the terminal, B. This terminal moves along a slide and carries the spring with it, and by means of the screw, C, the pressure of the spring against the metallic rod, D, is regulated. This rod is supported by a wooden support, E, and the whole is fixed onto the top of a wooden sounding box, F, which has a projecting piece, G, by means of which it may be clamped down to the bench when in use. On regulating the pressure with which the spring presses against the rod, and the position on the spring of the point of contact, a point will be found on which the spring, when pulled on one



AN ELECTRICAL TREVELYAN ROCKER.

side and released suddenly, will vibrate freely in a transverse direction. If, while the spring is thus vibrating, an electric current of a definite strength be passed through the bar and down the spring, the vibrations will be maintained and a musical note will be given out, the pitch of which depends on the length of the free end of the spring. The temperature of the spring and rod gradually rises until a point is reached at which the vibrations cease.

If the apparatus is immersed in water or alcohol just deep enough to cover the point of contact between the spring and rod, the vibrations take place as before, but the sound emitted is weaker. By placing a small split bullet in various positions on the free end of the spring the rate of vibration may be varied and the amplitude increased, and by fixing a small concave mirror on to the spring and reflecting a spot of light from it onto a screen the vibrations may be magnified and observed.

The steel spring may be replaced by one of platinum or German silver, but in these cases the vibrations are more feeble. Rods of almost any hard metal may be used, but steel gives the best results, and is followed by iron, German silver, platinum, brass, gas carbon, aluminum and nine-carat gold, in the order named. I have not been able to obtain any sustained vibration with rods of copper, silver, tin and lead, although even with these metals the dying away of the vibration appears to be considerably retarded by the passing of the current. No visible sparking takes place, and there seems to be no interruption of the current.

These phenomena appear to be the effects of the heat gen-

[1] London "Electrician."

erated at the point of contact, although the fact of their taking place under water would at first sight seem to negative this assumption. The apparatus appears to be a sort of electrical Trevelyan rocker.

I have not been able to obtain any results with springs of good conducting metals, such as gold, silver and copper, with any current I have used.

ELECTRIC HEATING.[1]

BY EDWARD PUCHTA.

THE possibility of heating air by electricity for warming purposes has always existed, but its limited application is for the most part due to the cost of generating the electricity, as compared to some of the other more direct methods of heating. I say more direct, because in the case of an ordinary low pressure steam heating system, or a hot water heating system, we have what may possibly be termed one conversion of energy, viz., the generating of heat by the burning of fuel, which is then given up directly to the water in either case, and then distributed throughout the system in the form of low pressure steam or hot water; whereas in the case of an electric heating apparatus we have this conversion or change to high pressure steam usually, then by means of steam engine it is converted into mechanical energy, and lastly, by dynamo into electrical energy, whence it is distributed and again converted at any desired place into heat energy, by individual machines, as we may rightly term electric heaters. However, in our modern electrical plants electricity is generated on such a large scale, i. e., in such quantities, as to minimize cost of production, and this makes it possible for electricity to compete very favorably in some cases with steam or hot water, especially when its advantages over the other systems are properly presented and considered.

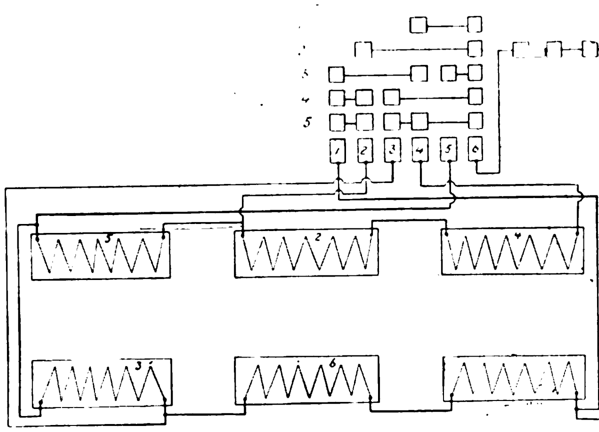


DIAGRAM OF CONNECTIONS OF ELECTRIC CAR HEATER.

Electric heaters designed for the artificial warming of air, are made in a great variety of forms, but consist essentially of a metallic conducting wire, generally of galvanized iron, or German silver, loosely coiled, so as to give an extended radiating surface, and supported in the air on insulators. This makes the heater what may be termed an air heater, the resisting conductor being so arranged as to permit the air to strike it directly and thus carry away the heat by convection currents. Such a heater serves its purposes best when it rapidly imparts its heat to the surrounding air and never itself acquires a dangerously high temperature. This latter fact is taken care of automatically in case iron wire is used in the heater, on account of its variable resistance for varying temperatures.

For example, a coil of iron wire, having a resistance at 0° C. of 100 ohms, has its resistance doubled when the temperature is raised to 180° C., and its resistance is increased to 500 ohms when its temperature is 525° C. The change of resistance in German silver, on the other hand, is but a mere fraction of this, for the same changes of temperature.

An article by Mr. J. F. McElroy cites the following case: Two electric heaters, one of German silver, the other of iron wire, both having the same resistance at 0°C. and both being covered with a non-conducting hood to prevent the escape of heat, will, as the temperature rises, act very differently.

For example, if the temperature rises to 300° C., only two-fifths as much current would pass through the iron wire heater as passes through the German silver one. This throttling action of the iron wire increases even more rapidly than the temperature, so that at 600° C., about one-fifth as much current passes through the iron wire heater as through the German silver. In each case the reduction of current means also a reduction in the amount of heat generated, the latter being directly proportional to current flow. A commercial heater, therefore, provided with an iron resisting conductor has this peculiarity, that, if for any reason the escape of heat from itself is prevented, either purposely or accidentally, the action of the consequent rise of temperature upon the heater itself is to throttle the amount of current passing through it, current flow being inversely proportional to resistance offered it, and hence the amount of heat generated, so as to prevent in the end a dangerously high temperature.

Heaters used on electric railroad circuits take their current from the mains at a constant pressure of generally 500 volts. In order to vary the current passing through the four or six heaters employed in each car a revolving or cylinder switch is used, by means of which the separate heater coils can be connected in series, or in parallel series, or some of them cut out altogether, thus permitting of a regulation of temperature and a supply of heat to meet any requirements.

The connections from the switch to the trolley wire and to the ground through the various heaters, for a car heated by six heaters, is shown in Fig. 1.

In position No. 1 all the coils or heaters are connected in series, so that the current passes through each in succession. This is the position of greatest resistance, and consequently of least current flow for a given pressure or voltage, and, therefore, of minimum rate of developing heat.

In position No. 2, two heaters are entirely cut out, which consequently diminishes resistance by one-third of itself, assuming that all heaters have the same resistance, and neglecting resistance of remaining conductors necessary for connections.

In the third position the six heaters are connected in two series of three each, giving a current strength in each set of three equal to twice the original current in the first position, making a total flow of current now of four times the original amount, and increasing heat producing power to four times the original.

The fourth position makes two series of two each, and entirely cuts out two remaining heaters, and the fifth position makes three series of two each.

In a heating coil it is intended that all the energy of the current passing through it must appear as heat, which is given directly to surrounding air by the cooling of the coils. Hence if we neglect the small portion of heat dissipated by conduction, an electric heater may be termed a nearly perfect machine for converting electric energy into heat energy.

The temperature produced in any given set of heaters in the case of car heating will depend largely upon the temperature of the external air, the speed of the car, direction and intensity of wind, construction of cars and care exercised by conductors in promptly closing doors when passengers enter and leave the cars. The number of people in a car also affects quite materially the amount of heat required. Experiments have been made in this direction, and it has been found that each person gives out about 190 B. T. U. of heat per hour, so that the heat given out by fifty persons will almost maintain the same temperature in the car that is required under average conditions.

We can readily determine the actual amount of heat produced in electric heaters when we know the current consumption, for if we multiply the number of amperes passing through the heater by the difference in potential at terminals of heater, and divide this number of watts by 1,050, we get very nearly the number of B. T. U. of heat generated per second in the heater.

The Metropolitan West Side Railroad Company, of Chicago, use electric heaters for warming their cars. There are twelve heaters for each car, connected up in three sets or series of four heaters each, with an independent switch for each set. The cars have an average capacity of 2,200 cubic feet, and about 200 square feet of glass surface. Each of the two sets of large heaters takes about 2,600 watts, and the set of small heaters about 1,800 watts, making a total of 7,000 watts per car when all circuits are on, and it is said that this will keep the car temperature between 56° and 60° F. when the outside temperature is from 0° F. to 10° F. below zero.

Some statistics show the cost of heating cars by electricity to be $2 per horse-power, per month, this being made possible by the fact that the generating plants have been erected with good boilers, efficient engines and large unit generators.

Outside of car heating, these heaters have been used in the heating of office buildings—that of the Cataract Construction Company at Niagara Falls being an example.

In England and France some large installations have also been made, that of the Vaudeville Theatre of London being probably the largest one. In designing the heating system for

[1] Read before the Chicago Electrical Association, May 15, 1896.—Abstract.

this latter building the engineers had to compete with a hot water heating system. It is now found that in ordinary cold weather only two or three hours of heating is necessary, whereas, in the case of a hot water system, for the same purpose, it would require two or three hours' time to heat up the water of the system alone.

In conclusion I might cite a few cases in which electric heat is used to advantage in other directions. Enough has been accomplished to show that electric cooking apparatus is practicable and economical in running cost, and very simple to operate.

An equipment in a brush factory for heating pitch to a temperature of 300° to be used to fasten bristles in the brushes has given entire satisfaction. Hot plates and glue pots are also heated by electricity, and an installation in a linen factory of 125 nine-lb. sad-irons heated to a surface temperature of 750° is another success.

Finally, to quote from an article by Mr. M. S. Hadaway, Jr., "It is not too much to claim that electric heating will materially influence the work of heating and ventilating engineers. Now that electric lighting installations are handled by heating and ventilating engineers, it is a short step to render the entire heating system homogeneous, looking to one source —the boiler—for all the energy needed for heating, ventilating and lighting."

STREET LIGHTING CONVENTION AT NEW HAVEN.

At the street lighting convention, held in New Haven, June 18 and 19, a number of papers were read of an electrical nature, among them the following: "Merit of the Insulated Pole," by E. E. Davis, Boston; "Electric Street Lighting," by M. J. Francisco. Much of the time of the convention was occupied by papers and discussions on the question of municipal ownership, among the latter being papers on "Municipal Ownership of Gas and Electric Plants;" affirmative, T. B. Persse, Hartford; negative, Allen R. Foote.

The following officers were elected for the ensuing year: President, B. L. Lambert, New Haven; vice-presidents, H. A. Knight, Worcester, Mass.; Oliver E. Green, Providence, R. I.; C. E. Thompson, Binghamton, N. Y.; secretary, Henry Hopkins, New Haven; treasurer, Joseph Births, Hartford; Executive Committee, D. Huntley, Jr., Allegheny, Pa.; Thomas E. Diveney, Fall River, Mass.; J. F. Fagan, Portland, Me.

The exhibits were shown in rooms 10 and 11, City Hall, and the convention was held in the aldermen's chamber. The companies to show exhibits were the Boston Electric Insulated Pole Company, Boston; E. P. Gleason Manufacturing Company, New York; S. W. Scranton, New Haven; H. Hungerford, Hartford, and a number of gas exhibits. Some street signs were also shown by S. W. Scranton.

EDUCATIONAL.

CORNELL UNIVERSITY ELECTRICAL COURSE.

We are in receipt of a catalogue announcing the courses of instruction in physics in the Cornell University. The equipment of the apparatus rooms of this department is a very large one, being valued at about $50,000, and contains a very complete outfit of electrical apparatus and instruments of precision.

Work in applied electricity is carried on in a separate building arranged for that purpose. On the lower floor of this building is the dynamo laboratory of the department, a room 35 x 100 feet. It contains two main lines of shafting extending the entire length of the room and each driven by an electric motor of 50 horse-power. More than forty dynamos and motors of various types and sizes are in constant use for experimental purposes and there are available also large batteries of accumulator cells (about 150 cells). Alternating currents of various potentials are obtained by means of specially constructed transformers, directly from the lines of the city company. The upper floor of this building contains laboratories for electric light photometry and for various studies in electro-technics.

PERSONAL.

MR. E. J. WESSELS, general manager of the Standard Air-Brake Company, leaves for Europe on June 30, to look after the interests of his company abroad. We dare say he will return with a good batch of new, as well as repeat, orders as the result of his trip.

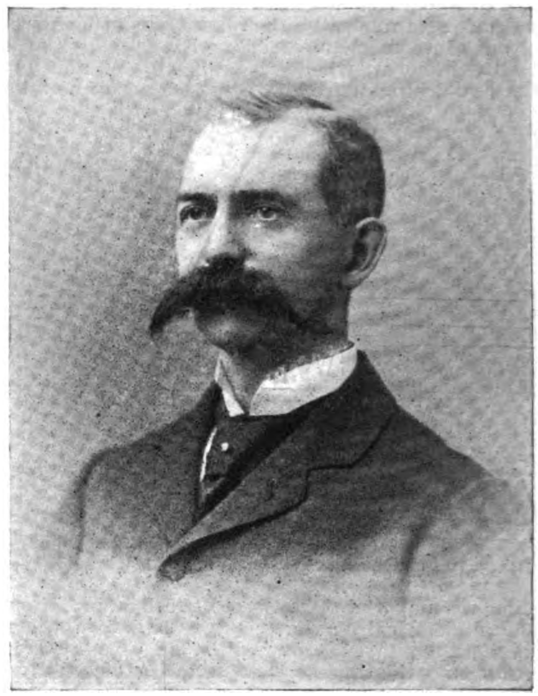
MR. ETHAN ALLEN DOTY, president of the Brooklyn Edison Company, is off on a pleasure tour through Europe, and is expected to return about September 1. Besides being president of this company, Mr. Doty is also a member of the well-known paper manufacturing firm of Doty & Scrimgeour. During Mr. Doty's absence Mr. Edward Packard, the vice-president of the Brooklyn Edison Company, is acting in his stead.

OBITUARY.

HARRISON J. SMITH.

It was but a few weeks ago that we gave a brief account of the valuable labors of the late Harrison J. Smith in connection with the recent Electrical Exposition in New York, and last week it was our sad duty to announce his untimely end in the prime of life.

Mr. Smith was born in Hector, Schuyler County, New York, in 1854, and received a common school education in Elmira. During his early life he worked as a carpenter in the Pullman car shops, and subsequently as a machinist on engine construction. He also fired a locomotive for a short time.



HARRISON J. SMITH.

In 1881, house carpenters were advertised for by the Edison Electric Illuminating Company of New York in connection with the construction of the historic Edison station in Pearl street, and Mr. Smith, with a few others, was engaged. He continued with the company as carpenter and machinist until 1883, and, after an interim of a month, entered the meter department and subsequently became its head. He left the company for about a year to engage in the wiring business, but returned in October 1885, as electrician of the Pearl street station under Mr. Chinnock, and subsequently became superintendent of the first district. Later on he was appointed general operating superintendent of the company, which position he occupied at the time of his death. The funeral services, according to the Masonic rites, were held at Scottish Rite Hall on June 18, and were attended by a host of the sorrowing friends of the departed, to whom he had endeared himself by his ever-cheerful and kindly disposition.

MICHAEL J. SULLIVAN.

We regret to announce the death, at Washington, D. C., on June 12, by appendicitis, of Mr. M. J. Sullivan. As the former representative of "The Electrical World" in New York and later in Chicago, Mr. Sullivan enjoyed a wide circle of acquaintanceship among the electrical fraternity, who will regret his untimely taking off. Mr. Sullivan leaves a widow, to whom we extend our sincere sympathy.

EXHIBITION NOTES—VII.

EXHIBIT OF THE BABCOCK & WILCOX COMPANY.

THE exhibit of the Babcock & Wilcox Company, makers of forged steel sectional high pressure boilers, was situated on the ground floor and covered a space of 500 square feet. They exhibited the various parts of their sectional water tube boilers, arranged in such a manner that the visitor was afforded every opportunity for the most critical examination of each individual part. The lighting of the exhibit was a feature that drew forth pleasing comment from many visitors.

A 36 inch steam and water drum was shown arranged on rolls, which enabled the attendant to so revolve the drum as to bring into view every portion of its construction in order that the visitor might more minutely examine the design and workmanship. The cylindrical portion of the drum is made of three sheets of open hearth steel. The longitudinal seams are butt-strapped inside and out. All holes are punched five sixteenths of an inch smaller than the diameter of the rivets to be used, through steel templates, and drilled out the full size after the sheets are rolled and assembled with the butt-straps in position. After drilling, the straps are removed, all burrs cleaned off and the plates re-assembled, metal to metal, with parallel turned bolts fitting the holes before riveting. Each course is then built independently to template.

The various courses and their heads are assembled by a hydraulic forging press at a pressure of 12 tons. All rivets are driven with a 60 ton pressure and held until cold. The drum-heads are fitted with manholes. These are forged at a single heat with the extra manhole rings and stiffening plate in position and have flat raised seats for stand pipe and feed connections. The edges of the head and manhole faces are

EXHIBIT OF THE BABCOCK & WILCOX CO.

machined off true. The manhole fittings are of forged steel. The plate is machined first and turned to a true oval to fit the head. The steam flanges are of forged steel recessed to make a male and female joint, fitted with stud bolts, tapered threads and inside keeper nuts. This standard steam and water drum is tested in the shops and again when erected on the purchaser's premises to 300 pounds hydrostatic pressure.

The cross-boxes into which are expanded the water circulating uptakes are forged from a single sheet of open hearth steel without seams or rivets.

The three sections shown, and used as a fence around the exhibit, were built up of 4 inch tubes expanded into forged steel headers. These tubes are made of the best knobbled and hammered charcoal iron blooms of standard weight and of such quality that a 1,500 pound hammer dropped five feet onto a tube shall crush the tube without showing cracks or flaws. These sections are subjected to a hydrostatic pressure of 400 pounds after assembling.

The header shown standing upon end is forged from a single sheet of open hearth steel, serpentine in form, disposing the tubes in a staggered position when assembled in the furnace. The method of expanding the tubes was shown, as also the cap clamps and handhole fittings.

The handholes are of sufficient size to permit the cleaning, removal and renewal of a tube, the handholes being placed opposite the tube ends. They have a raised seat milled off to a true surface and covered on the outside with a forged steel cap (also milled to a true surface) and held in position by a forged steel safety clamp, closing the handhole opening on the inside and secured by a bullhead bolt to secure correct alignment, and a forged cap nut. This method of closing handholes is a perfect one mechanically, insuring a tight joint, metal to metal, without packing of any kind.

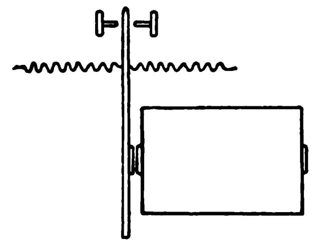
They also showed a line of high pressure brass steam boiler fittings designed for any pressure demanded. These fittings are the design of the company and are now in use on boilers working at 350 pounds pressure. Photographs of many of the large plants installed by the company were exhibited, and also photographs of their chain-grate automatic stoker. There was also shown a model of the company's standard high pressure sectional boiler. The historical side was represented by the original model of the inclined water tube boiler constructed by Mr. Stephen Wilcox, in 1856.

TELEPHONY AND TELEGRAPHY.

A SENSITIVE RELAY.

BY D. B. GRANBY.

I NOTE in your issue of May 20 a description of a sensitive relay, the device of Mr. MacDonald, of Australia. In principle, this device is identical with one I have used for many years in bad weather in St. Louis. Herewith is an illustration of it, as I use it. By using a retractile spring on each side of the armature of an ordinary relay, its sensitiveness



A SENSITIVE RELAY.

may be greatly increased. The arrangement is particularly valuable on repeater relays.

I am glad to say that the necessity for using this device has rarely arisen during the past two or three years, owing to the high standard of insulation maintained on the wires of the Postal Telegraph-Cable Company.

A RAPID DEEP SEA CABLE REPAIR.

A MID-ATLANTIC ocean repair on the Pouyer-Quertier cable was recently effected in a very expeditious manner by the Telegraph Construction and Maintenance Company. It was all the more creditable, as it was on the much dreaded Flemish Cap, a spot so well known by all Atlantic navigators, and, when possible, always avoided by them on account of its frequent fogs and incessant gales.

This company's vessel, the "Seine," raised the St. Pierre end on May 15, spliced on a piece, payed out and buoyed it the same morning. She then proceeded 40 miles to the eastward, and on May 17 raised the Brest end, spliced on, payed out, and arrived near the St. Pierre buoyed end the same night; but a dense fog coming on, the cable had to be cut and buoyed. The fog lasted four days, and on the weather clearing, the buoys were sighted, after some hours' searching for them. Early on the morning of May 22, the two ends were spliced together and the repair completed.

This is claimed to be the quickest deep water repair ever made in the Atlantic, and had not the fog intervened, it would have been a marvellous one. The rapidity of the repair may have been aided by the fact of the "Francois Arago," which failed in repairing the break last winter, having left a mark-buoy, and this mark buoy was sighted by, and served as a mark for, the "Seine." The buoy which the "François Arago" had put on the St. Pierre end at the same time was not found by the "Seine." The break occured in June, 1895, and another vessel went out last Autumn, but returned without having effected the repair, although she cut into the cable to the eastward of the Flemish Cap.

The "Seine" on her way out from London had effected considerable repairs, 235 miles from Brest, on the same cable. She left London April 25, called at Havre for cable, remaining there three days, and after effecting the two repairs above named, got back to London May 30—exactly five weeks.

BOYS ON BIKES.—The American District Telegraph Company, of New York, has mounted a squad of its boys on bicycles, in natty uniforms and tan leggins. They are all experts, and will greatly expedite the service.

THE NEW YORK TELEPHONE CO.

The New York Telephone Company was incorporated on June 19 by the Secretary of State, with a capital of $16,000,000, to construct, buy, or lease lines of electric telegraph and telephone to be operated in New York City, and thence to Albany and Boston and the intermediate cities, towns, and places in New York, Massachusetts, Rhode Island and Connecticut; also across or under the North and East rivers and New York harbor to Jersey City, Long Island City, Brooklyn, and Port Richmond, S. I.; also through New Jersey to Philadelphia, and to the intermediate cities and towns; also from Long Island City and Brooklyn to Montauk Point, L. I., and to the intermediate cities and towns; also from Port Richmond, S. I., to all places in Staten Island, and also to other cities, towns, and places in the States mentioned, and to connect with other lines leading to places outside of the territory.

The incorporators are: Charles F. Cutler, of Morristown, N. J.; John H. Cahill, Joseph P. Davis, Thomas T. Eckert, William T. Bouchelle, James Merrihew, and William H. Wolverton, of New York City; William H. Forbes, John E. Hudson, of Boston; George J. Gould, of Lakewood, N. J.; John Jameson and Charles A. Tinker, of Brooklyn, and John Van Horne, of Bayonne, N. J. The capital stock is divided into 160,000 shares, and each of the incorporators subscribes for ten shares. The company paid the State a tax of $20,000 for the privilege of incorporation.

The directors of the new company named in the articles of incorporation represent the following companies: Western Union Telegraph Company, George J. Gould, Thomas T. Eckert, Charles A. Tinker, James Merrihew, and John Van Horne; American Bell Telephone Company, John E. Hudson and W. H. Forbes; Metropolitan Telephone Company, Charles F. Cutler, John H. Cahill, Joseph P. Davis, William T. Bouchelle, William H. Wolverton, and John Jameson.

Much interest has been aroused and much speculation is rife on the scope and objects of this new company, many surmising that it is the opening wedge to a closer union between the Western Union and American Bell interests. The directors promise to issue an official statement on the subject within a few days. In the mean time, we are able to announce that the Metropolitan Telegraph and Telephone Company, of New York, has been transferred to the new company.

SOCIETY AND CLUB NOTES.

SIXTH ANNUAL CONVENTION OF THE CANADIAN ELECTRICAL ASSOCIATION.

THE Sixth Annual Convention of the Canadian Electrical Association opened in the rotunda of the Board of Trade Building at Toronto, Canada, at 2:30 p. m., on Wednesday, June 17. The attendance was one of the largest in the history of the association.

Mr. A. B. Smith, superintendent of the Great Northwestern Telegraph Company, the president of the association, occupied the chair. The convention having been called to order, the president delivered a short address which was greeted with applause. The secretary-treasurer, Mr. C. H. Mortimer, read the secretary-treasurer's report.

Mr. E. Carl Breithaupt read the report of the Committee on Statistics.

The president stated that a great many new members had come in and he was gratified to know that many of them were central station men.

The first paper on the list to have been read was a paper on "Ocean Cables," by Mr. C. P. Dwight, but, owing to the large amount of time necessary to prepare such a paper, Mr. Dwight had not been able, owing to press of business, to prepare the necessary data.

Mr. George Black, of Hamilton, read a very interesting paper on "Acetylene Gas," which he illustrated by a small apparatus which he had improvised for the occasion. A very interesting discussion followed the reading of this paper. The convention adjourned at 4:30 p. m.

In the evening an illustrated lecture was delivered by Mr. James Miln, entitled "Radiant Matter," showing the development of the Röntgen ray, which very much interested and delighted the audience which assembled.

Thursday, June 18.—Morning Session.—President Smith again called the convention to order.

The question was raised as to where the next place of meeting should be held and after some discussion it was decided to hold the next annual convention at Niagara Falls in June, 1897.

The report of the Committee on Statistics brought in by Mr. E. Carl Breithaupt, was then discussed. Mr. Breithaupt suggested that as it was difficult at all times to get information with regard to prices, etc., and as central station men were very backward about giving information, a bureau of information be established and that the secretary, Mr. C. H. Mortimer, be paid a reasonable remuneration for taking charge of the same. The scheme suggested by Mr. Breithaupt was heartily concurred in by many of the members present. Mr. Mortimer very kindly consented to take hold of the scheme and stated that he would be willing for the first year to do the work gratis and until it was seen whether it would be a success, and if it should prove to be such that then the association could vote him some remuneration. The report of the Committee on Statistics on motion was received and adopted.

Mr. James Miln then read a paper entitled "Meters," which he illustrated by diagrams thrown upon a screen by a stereopticon. At the close of the paper it was actively discussed and many questions propounded by the members were answered by Mr. Miln.

The convention then adjourned until 2 o'clock p. m.

Thursday.—Afternoon Session.—The president called the convention to order, after which the election of officers and members of committees was proceeded with.

The members of the Committee on Legislation are as follows: Messrs. J. J. Wright, K. J. Dunstan, B. Powell, L. B. Macfarlane, F. H. Badger. Committee on Statistics—Messrs. E. Carl Breithaupt, John Yule and O. Higman.

The officers elected were the following: President, Mr. John Yule, of Guelph; Mr. L. B. Macfarlane, first vice-president; Mr. E. Carl Breithaupt, of Berlin, second vice-president; Mr. C. H. Mortimer re-elected to the office of secretary-treasurer.

As was customary, five members retired from the Executive Committee and the following five were elected to take their places: Messrs. Ross MacKenzie, Niagara Falls; A. B. Smith, Toronto; John Carroll, Montreal; Charles Hunt, London, and F. C. Armstrong, Toronto.

Mr. O. Higman spoke at some length on the question of the Government Inspection Act and the following committee were appointed to confer with the government to see whether some satisfactory arrangements could be made, as the present system of inspection was considered iniquitous by the members of the association: Messrs. J. J. Wright, P. C. Gossler, A. A. Dion, James Miln and E. Carl Breithaupt.

Mr. F. C. Armstrong then read a very interesting paper on "The Outlook for the Electric Railway," upon which considerable discussion followed.

As it had been arranged to hold an excursion and dinner at Lorne Park in the evening the convention adjourned at 4:30 for the purpose of enabling the members and their friends to take the boat for Lorne Park.

A very pleasant time was had at the park, where a group photograph of the members was taken.

Friday, June 19.—Morning Session.—The first thing on the programme for the morning was a paper on "Central Station Economics," by Mr. P. C. Gossler, of the Royal Electric Company, of Montreal. At the close of the paper considerable discussion followed, and it was conceded by all that this was one of the most valuable papers given at the convention.

The next paper on the list was "Power Transmission by Polyphase E. M. F.'s." As the time of the convention was limited, Mr. White Fraser, the author of the paper, kindly consented to give a synopsis of the paper, not taking time to read it in full. At the close of the paper some discussion followed.

The next was a paper on "Operating Engines without a Natural Supply of Condensing Water, or the Continuous Use of Injection Water," by Mr. E. J. Philip. Owing to Mr. Philip's unavoidable absence, the paper was read by Mr. Wickens. As the time for discussion on this paper was limited, and as the paper was considered to be a valuable one, it was decided to ask Mr. Philip to amplify his paper and present it at a future meeting of the convention.

After passing votes of thanks to the retiring officers, to authors of papers and others who had tendered courtesies, the association adjourned to meet at Niagara Falls in June, 1897.

STANDARD ELECTRIC RULES.

The Conference on Standard Electrical Rules which met in New York, on March 18 and 19, will not hold a meeting in June as was contemplated at the first meeting, as the Committee on Rules have not yet completed their report, and the meeting is deferred until a later date, probably in the autumn, of which due announcement will be made whenever a time is decided upon.

ANNUAL MEETING OF THE FRANKLIN INSTITUTE ELECTRICAL SECTION.

The electrical section of the Franklin Institute held its annual dinner on the evening of June 15, 1896. Among the prominent guests were Mr. John C. Trautwine, chief of the Water Bureau; Arthur Falkenau, president of the Engineers' Club of Philadelphia; W. H. Johnson, Russell Hawkins and E. A. Custer.

The president of the section, Mr. Clayton W. Pike, acted as toastmaster, and in addition to those already mentioned responses were made by Carl Hering, ex-president of the section; T. Spencer and William C. L. Eglin, vice-presidents; F. Uhlenhaupt, Jr., Paul Foster Leach and Dr. A. E. Kennelly.

LETTERS TO THE EDITOR.

FERRARIS AND ARNO'S SYSTEM OF DISTRIBUTION.

In your issue of June 3 you describe a supposed to be "new" system of distribution, by means of alternating currents. With all due respect to Professors Ferraris and Arno, allow me to say that my paper, read before the American Institute of Electrical Engineers, in 1894, contains the subject in a far broader way. No restriction is made therein to the number of phases of the transformed currents, nor to the frequency, but it is pointed out that from the single-phase source any kind of translating device may be supplied with its special current by the interposition of a phase splitting transformer, which in this particular case was a self-starting synchronous motor or motor generator.

It was shown that from the single-phase alternating current dynamo continuous currents, as well as bi-phase and polyphased currents, might be produced and distributed to translating devices, requiring currents of such character. Possibly some claims are made on the transformer described, but no means for starting the short-circuited armature of the transformer is shown nor described (if I am not mistaken). It would seen as if the armature had to be started manually or by some auxiliary device. LUDWIG GUTMANN.

Peoria, Ill., June 15, 1896.

INCANDESCENT LAMP PHENOMENON EXPLAINED.

I noticed in The Electrical Engineer of May 27 a letter by "O. C. R.," which I will endeavor to explain.

While making some X-ray experiments I had a peculiar thing happen. I was collecting static electricity from the belt of my alternator and neglected to ground the frame of the machine, whereupon my lightning arresters began to discharge.

Now, "O. C. R." probably has some ground connection near his belt and no path provided for the static charge on the frame of his machine, which would cause the lamp, when grasped firmly in the hand (thus forming a ground) to discharge from the filament. TOM LUDLOW.

Florence, S. C.

REPORTS OF COMPANIES.

ANNUAL MEETING OF THE ELECTRIC STORAGE BATTERY CO.

The annual meeting of the Electric Storage Battery Company was held at Philadelphia, on June 4, the feature of which was the report of its president, W. W. Gibbs. The substance of this was as follows: The gross sales of the company for the year 1895 were $328,231.40, and the margin of profit was $124,733, making the profits $126,951.87. The general expense during this period was excessive, due to the starting and general establishment of business throughout the country, aggregating $126,969.47, leaving a net profit for the year, after payment of all expenses, interest, etc., $2,982.40. The total plates made for the year amounted to 1,112,864 lbs. The increase of business operates to reduce cost per pound and the division of operating expenses over a greatly increased output produces a very greatly increased proportion of profit to business done. The gross business for the five months of the present year aggregates $415,000. The business for the year will amount to over $1,000,000, and a gross profit of over $600,000.

ANNUAL MEETING OF WASHBURN & MOEN CO.

At the annual meeting of the Washburn & Moen Manufacturing Company, held May 26, the old board of directors was re-elected as follows: President, William E. Rice; Vice-President, Treasurer and General Manager, Philip W. Moen; Directors, the above officials and George T. Dewey, Stephen Salisbury and Rockwood Hoar. It was voted to increase the capital stock from $3,500,000 to $4,000,000. A quarterly dividend of 2 per cent. will be declared.

WALKER CONSOLIDATION RUMORS DENIED OFFICIALLY.

For the past few weeks there have appeared in the daily press, and some technical papers, rumors, and in some cases specific statements, that the Walker Company, of Cleveland, had been bought up by the General Electric and Westinghouse companies, and, in fact, were a part of the large consolidated companies. We are informed by the officials of the Walker Company that there is not a word of truth in these statements and are authorized to deny them most emphatically and unequivocally. They admit that overtures have been made to them with a view to some arrangement of this kind, but that they have not been accepted. The Walker Company wish it to be distinctly understood that they are entirely independent of the General Electric and Westinghouse companies, and are now in a position to compete with them in all kinds of electrical business. An officer of the Walker Company goes so far even, as to state that they were recently offered the factory in Cleveland, now occupied by the Brush Electric Company.

The Walker Company will soon be in the market with a complete line of alternating apparatus for power and lighting, both of the vertical and horizontal type, and will be ready to enter any field of electrical work. They also report that they are making rapid progress with their arc light machines, and that they will soon have on the market a complete line of arc light apparatus, all of which work is now being done at their New Haven factory, the inside of which presents the appearance of a veritable forest of small tools for lamp work.

THE CATARACT POWER AND CONDUIT CO., OF BUFFALO.

The Cataract Power and Conduit Company, of Buffalo, has been incorporated, with a capital stock of $2,000,000, to furnish Buffalo with electricity. It is, in fact, to act as the distributing agent of the Niagara Falls Power Company, the same interests involved in the one supporting the other. The Buffalo concern will relieve the parent company of the necessity of a strict supervision of the sale and distribution of electricity in that city. The business in Buffalo will be conducted under a different name and the operations directly overseen, instead of being superintended from New York City or the office at Niagara Falls. The directors of the Cataract Power and Conduit Company are Daniel O'Day, E. D. Adams, Francis L. Stetson, Edward L. Wickes, Wm. B. Rankine, D. O. Mills and John Jacob Astor, all of New York City; George Urban, Jr., and Charles R. Huntley, of Buffalo.

The work of laying the conduits will be begun shortly, according to the plans and specifications filed by the Cataract Construction Company with the Buffalo Board of Public Works two months since. The main conduits will be laid first and the smaller streets will be supplied if the demand increases. The first conduit will be laid in Court street. The parent company is now busy at laying its transmission lines to Buffalo. By the terms of the franchise the power must be there by June, 1897. The main distributing conduits in Buffalo will be completed when the electricity is delivered at the city line.

LEGAL NOTES.

THE RIGHT TO SET RAILWAY POLES IN FRONT OF PROPERTIES.

On June 15 a decision was rendered in the New Jersey Court of Errors and Appeals in regard to the right of corporations to set poles in front of private properties without the consent of the owners. The decision answers the question in the affirmative.

The case was that of Mrs. Washington A. Roebling against the Trenton Traction Company. A trolley pole was erected in front of her mansion on West State street, despite her opposition, and the Court of Errors affirms the decision of the Supreme Court that ordinances granting such rights to trolley companies are not unconstitutional. If Mrs. Roebling can show special damages, the court says she may find redress by suing to recover.

INVENTORS' RECORD.

CLASSIFIED DIGEST OF U. S. ELECTRICAL PATENTS ISSUED, JUNE 16, 1896.

Alarms and Signals:—

ELECTRICAL PILOT OR SIGNAL. H. H. Franklin, Brooklyn, N. Y., 561,982. Filed March 18, 1896.
An alarm adapted for use on board a vessel for determining the depth of water.

FIRE ALARM SIGNAL BOX. J. J. Ruddick, Newton, Mass., 562,-034. Filed Oct. 8, 1894.
A non-interference box intended for use in a system where a number of boxes are arranged in series in a circuit.

AUTOMATIC BLOCK SYSTEM. J. Shoecraft, Harveyville, Kan., 562,253. Filed Aug. 8, 1895.
Comprises a motor, stopping wheel driven from the said motor and provided with a lug adapted to engage the armature lever, a wind wheel shaft driven from the said stop wheel and carrying a wind wheel connected to a pawl and ratchet with the wind wheel shaft.

RAILWAY SIGNAL. F. McBrien, Newark, N. J., 562,318. Filed April 1, 1896.
Permits the rails of the track to serve as the only conductors connecting the sections.

ELECTRIC BURGLAR ALARM. H. Rohrdantz, Buffalo, N. Y., 562,325. Filed Jan. 30, 1896.
A time mechanism for actuating the detonating devices in various parts of the house.

Primary Batteries:—

PRIMARY BATTERY. R. P. Osgood, Salem, Mass., 562,019. Filed Sept. 30, 1895.
Comprises a copper cup provided with openings closed by fibrous material; a positive pole suspended within said cup and a partition of felt between said poles.

Conductors, Conduits, and Insulators:—

INSULATOR. T. Blankinsop and J. W. Brown, Martin's Ferry, O., 562,166. Filed March 24, 1896.
A glass insulator for wires, having a wire engaging groove, a screw stem reinforced with an embedded metal plug and a rim or jacket depending over the stem from the base of the groove.

TESTING JOINT FOR ELECTRIC CONDUCTORS. B. L. Toquet, Westport, Conn., 562,261. Filed April 14, 1896.
Consists of a frame connecting conductor ends, with an interposed insulation and an adjustable piece to make or break the electrical connection across the insulation.

Distribution:—

ELECTRIC DISTRIBUTING SYSTEM. R. R. Bowker, Brooklyn, N. Y., 562,209. Filed Feb. 27, 1896.
Means whereby a portion of a network of street conductors may be cut off from a supply station, or whereby a network of street conductors receiving current from two stations may be electrically divided into two parts receiving current from said stations, respectively.

Dynamos and Motors:—

DYNAMO ELECTRIC MACHINE AND ELECTRIC MOTOR. J. G. Germann and F. B. Downing, Erie, Pa., 562,179. Filed March 26, 1896.
Relates to frames for electric motors and dynamos.

Lamps and Appurtenances:—

PENCIL FOR ARC LAMPS. I. L. Roberts, Brooklyn, N. Y., 562,-030. Filed Oct. 31, 1895.
A cylinder of carbon with a core of a material containing chromium.

ELECTRIC ARC LAMP. M. S. Okun, New York, 562,090. Filed April 8, 1892.
An air-tight globe provided with a valve for the emission of gases, and details of lamp mechanism.

SAFETY LAMP. William Waegel, Philadelphia, Pa., 562,208. Filed Oct. 22, 1895.
The case inclosing the incandescent lamp is filled with carbonic acid gas under pressure.

ELECTRIC ARC LAMP. O. S. Lyford, Jr., Chicago, Ill., 562,313. Filed April 6, 1896.
The combination with an inclosing chamber normally sealed from the external air, of a porous diaphragm for securing the equalization of the external and internal pressures.

Measurement:—

ELECTRICAL ENERGY INDICATOR. T. Duncan, Fort Wayne, Ind., 561,977. Filed Nov. 11, 1895.
Comprises a movable wound armature, a commutator, and elastic brushes for neutralizing any vibration imparted to them.

Miscellaneous:—

ELECTROGALVANIC BELT. A. Dow, Wooster, O., 561,975. Filed Feb. 17, 1896.
Details of construction.

THERMOSTAT. E. S. Brazelton, So. Pittsburg, Pa., and T. J. Zoeller, Nashville, Tenn., 562,353. Filed May 1, 1895.
Comprises a frame having an annular groove, a section of a hollow sphere of thin metal having its perimeter flanged, a spring whereby it may be firmly clamped in place in such frame, and co-operating contact pieces.

DIAPHRAGM FOR ELECTROLYTIC PURPOSES. Martin Kiliani, Neuhausen, Switzerland.
Permeable membrane placed between an outer and an inner series of supporting lathes or bars.

Railways and Appliances:—

TROLLEY. J. H. Holland and P. F. Glazier, Indianapolis, Ind., 561,991. Filed Aug. 23, 1895.
Comprises a self-lubricating bushing for trolley wheels and a swivel connection between the wheel and the pole.

RAIL BOND OR CONNECTION. H. P. Wellman, Catlettsburg, Ky., 562,055. Filed July 9, 1895.
A bond wire having iron or steel terminals and a copper bar or connection electrically welded thereto at its opposite ends.

CONTROLLER FOR ELECTRIC CARS. E. A. Sperry, Cleveland, O., 562,100. Filed March 20, 1896.
A reversing switch, operating connections between the cylinder and the movable contacts of said switch, and means for reversing the relative movement of said contacts when the car is to run in the opposite direction.

TROLLEY FOR ELECTRIC RAILWAYS. M. T. Graf, Buffalo, N. Y., 562,132. Filed Jan. 14, 1896.
So constructed as to be readily removable from the yoke of the trolley pole.

ELECTRIC RAIL BOND. W. H. Wiggin, Worcester, Mass., 562,-107. Filed Aug. 28, 1895.
Employs a flexible connection between the two bond ends attached to the rail flanges.

ELECTRIC RAILWAY SYSTEM, ETC. C. Coerper, Cologne, Germany, 562,216. Filed April 4. 1896.
The car receives current from secondary conductors through transformers interposed between primary and secondary conductors.

TROLLEY WIRE SWITCH. S. D. Cushman, Akron, O., 562,356. Filed Feb. 25, 1896.
Consists of line and switch wire terminals, and a rocking tongue to bring either switch terminals in alignment with the main terminal.

EMERGENCY ELECTRO BRAKE. Benjamin F. Card, Brooklyn, N. Y., 562,118. Filed Feb. 6, 1896.
Details of construction.

Regulation:

REGULATING ALTERNATING MOTORS. A. H. Armstrong, Schenectady, N. Y., 562,062. Filed Jan. 11, 1896.
An induction motor having a revolving and stationary part, with a ratio of transformation other than one to one, and a switch adapted to interchange the terminals of the revolving and stationary parts.

Switches, Cut-Outs etc.:—

AUTOMATIC ELECTRIC SWITCH. W. S. Barstow, Brooklyn, N. Y., and R. Lindslay, Cleveland, O., 561,958. Filed June 5, 1895.
Movable parts are controlled in their movements by a motor.

CONTROLLER FOR ELECTRIC MOTORS. E. A. Bryant, Washington, D. C., 562,116. Filed April 18, 1896.
In combination with a suitable resistance coil or device, a lever provided with a contact arranged to vary the resistance included in circuit, as the lever is rocked and a reversing switch carried by the lever and adapted to be actuated by a lateral movement of the foot of the operator without rocking the treadle.

ELECTRIC SWITCH. J. F. McElroy, Albany, N. Y., 562,142. Filed Dec. 29, 1894.
A cylinder carrying a connecting plug at one end thereof in permanent electrical connection, with a source of supply through the axle thereof, brushes arranged to receive electricity from said plug, and a secondary plug in the periphery thereof adapted to electrically connect corresponding brushes, one of which is electrically connected with one of the first-named brushes.

Telegraphs:—

TELEGRAPHY. E. F. Law, London, England, 561,004. Filed Jan. 8, 1895.
A synchronous multiplex system, with special regulating devices.

Telephones:—

TELEPHONE SWITCHBOARD. G. S. Maxwell, Richmond, Va., 562,009. Filed March 17, 1896.
Means for automatically completing the local circuit of any subscriber's line.

TELEPHONE SWITCHBOARD. G. S. Maxwell, Richmond, Va., 562,010. Filed March 17, 1896.
Means to prevent the annunciator or drop from being operated by the influence of a current which might be sent into the line at the spring jack when another circuit line is connected therewith.

TELEPHONE SWITCH. G. S. Maxwell, Richmond, Va., 562,013. Filed March 25, 1896.
Either the call wire or the wire of the magneto system may be used by the subscriber to call the central office.

TELEPHONE SWITCHBOARD. G. S. Maxwell, Richmond, Va., 562,012. Filed March 20, 1896.
A table carrying spring jacks, switches and connecting plugs, and a board carrying annunciators and a transmitter, the said board and table being hinged together.

TELEPHONE SWITCH. G. S. Maxwell, Richmond, Va., 562,013. Filed March 25, 1896.
A circuit changing device in combination with a receiver and induction coil connected in series with each other, and in multiple with a magneto generator, bell and condenser, whereby the condenser is brought in or out of the circuit according as the circuit changing device is moved in either direction.

SYSTEM OF TELEPHONIC EXCHANGE.—Salomon Berditschewsky, called Apostoloff, London, England, 562,064. Filed March 23, 1896.
An improved system of telephone exchange, whereby any two subscribers may communicate without the intervention of any attendant at the central station and without increasing the number of wires beyond the double circuit generally used.

NEWS AND NOTES.

ALTERNATING ARC LAMPS WANTED AT BARTON, VT.

The electric light plant which the village of Barton has built has now been in successful operation for the past three months without the slightest interruption. It is said to be the longest line of transmission in the Eastern States, the distance from dynamo to substation being 14½ miles, operated at about 6,000 volts. So far the streets of the town are lighted only with a few temporary arc and incandescent lights. The city is in the market for alternating arc lamps of any manufacture with which to light the streets. Communications relating to arc lamps, and giving all possible details, will be received and should be addressed to Mr. Ernest Gonzenbach, electrical engineer.

Trade Notes and Novelties

AND MECHANICAL DEPARTMENT.

GARTON LIGHTNING ARRESTERS.

WE illustrate herewith several of the improved 1896 types of Garton lightning arresters, manufactured by the Garton-Daniels Electric Company, of Keokuk, Iowa. These arresters number among their many good qualities positive action, reliability, efficiency and durability. Fig. 1 represents the street railway station type, which is handsomely mounted on a base of white Italian marble. This improved type takes less than one ampere at 500 volts on a short circuit and after severe tests has been adopted by several large electric railways in Chicago and St. Louis. The Garton M. C. station arrester made for 52 and 104 volt secondary, 110, 220 volt three-wire, 500 volt-power, 1000 and 2000 volt primary circuits, are similar in appearance to that shown in Fig. 1. These are also made for two- and three-phase alternating and arc circuits of any voltage. Fig. 2 represents the Garton pole arrester, and the street car arrester is similar to it. Fig. 3 shows the station arrester mounted on a marbleized slate base. Any kind of base is furnished to match the switchboard. Fig. 4 shows a "kicking coil" which is designed to be placed one on each side of the circuit between the apparatus to be protected and the arresters. The inductive resistance thus introduced causes the discharge to go to ground through the arrester.

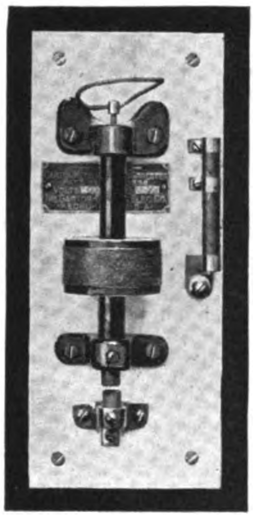


FIG. 1.

FIG. 2.

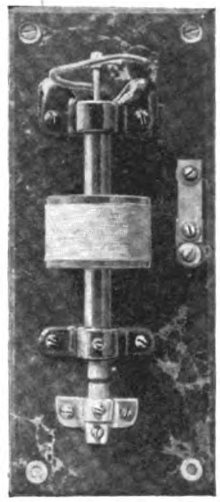


FIG. 3.

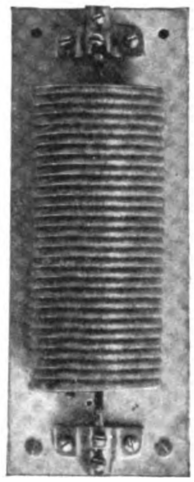


FIG. 4.

ECONOMIES IN COAL PRODUCTION.

The Jeffrey Manufacturing Company, of Columbus, O., have issued a catalogue of their mining machinery, with which is incorporated a paper by Mr. Cyrus Robinson, M. E., read before the joint meeting of the Western Pennsylvania Central Mining Institute and the Ohio Institute of Mining Engineers. The paper states that where a mine is free from gas and the roof ordinarily good, it does not require a very extended investigation to prove the advantage and economy of electricity over all other systems of power transmission for your coal mine. The following table, giving the cost of wire and pipe installed, based on the present market price of material and labor, shows very conclusively the superiority and economy of the electric system of transmission as compared with pneumatic:

Horse-power delivered.	Distance, in feet.	System of transmission.	Total loss in the line.	Cost of line installed.
100	5,000	Compressed Air.	10%	$2,350.00
100	5,000	Electric 250 Volts.	10%	837.50
100	5,000	Electric 550 Volts.	10%	280.00

Guided by the above figures the inclination would be to decide in favor of the electric 550 volt transmission, and if the vein of coal had an average thickness of not less than five feet, the decision would be correct.

MR. C. A. ECK, 116 Wooster street, has a very busy shop, turning out the many orders for his improved fan motors. Aside from these, Mr. Eck is also a manufacturer of larger dynamos and motors, all of which are his specialties.

SNOW STEAM PUMPING ENGINES.

A beautifully illustrated souvenir catalogue was issued by the Snow Steam Pump Works, of Buffalo, N. Y., on the occasion of the convention of the American Waterworks Association, in Indianapolis, Ind. The catalogue is not only an example of the highest art of the engraver, but contains a great deal of interesting and valuable information on the subject of pumping, from the primitive moss-covered bucket of our forefathers and the later town pump down to the largest triple expansion pumping engines which are now found doing service for municipal and other waterworks.

A number of the modern plants are illustrated, in which the Snow pumping engines are installed, among them being the plant at Fairhaven, Conn., in which the interior of the engine house is tastefully decorated with flowering plants, palms and tasteful rugs which leave the impression of a well-appointed drawing room rather than that of a pumping station. Several types of cross-compound horizontal pumping engines are shown, also the modern fire pump, compound duplex, low service pumps, double tandem compound pumping engines, sewage pumps and other special patterns too numerous to mention.

The interior of the Snow company's works at Buffalo is shown, in which the various parts of the pumping engines are under construction. The shop is equipped with traveling cranes and conveniently arranged machinery for manufacturing and handling the enormous castings which go to make up the large pumps for city service.

STOW FLEXIBLE SHAFTS.

The manifold uses to which flexible shafts may be applied are well illustrated in the catalogue of the Stow Manufacturing Company, just published. These shafts are of great importance as time and labor savers wherever, on account of the size, weight or position of the work, it is desirable to take the tool to the work instead of taking the work to the tool. Drilling, tapping, reaming, grinding and polishing are all accomplished by means of these shafts, which can be bent so as to bring the tools into almost any position relative to the work.

For drilling rails for bonding a combination flexible shaft and electric motor has been put on the market for the use of electric railway track builders and has met with excellent success. Another adaptation of this shaft is in the radial flexible bicycle drill, which is largely used, although it has been on the market only since the beginning of this season. Special tools of innumerable styles are also manufactured by this company for use in connection with these flexible shafts, and all machinery which it turns out is made on the interchangeable system.

THE SOUTHERN ELECTRICAL MANUFACTURING AND SUPPLY CO. ABSORBED BY THE GENERAL ELECTRIC CO.

The General Electric Company has purchased the stock of the Southern Electrical Manufacturing and Supply Company, of New Orleans, La., and has succeeded to the business thereof. The General Electric Company will increase the stock of the Southern company, and intend to extend the business.

A LARGE SHIPMENT OF WESTINGHOUSE APPARATUS.

ONE of the largest single shipments of electrical apparatus was shipped recently by the Westinghouse Electric and Manufacturing Company to Great Falls, Montana. The shipment filled eight freight cars and the freight on that cargo to its destination amounts to $8,000. The machinery will be used by the Boston and Montana Consolidated Copper and Silver Mining Company in the refining of copper and silver, and it is the largest machinery of its kind ever constructed for electrical refining purposes.

The Boston and Montana Company is one of the largest copper mining concerns in the Northwest. Until a few years ago

ELECTRIC TRAIN AT WESTINGHOUSE WORKS, BRINTON, PA.

the copper produced in that section was not refined, but the copper matte was sent east, and some of it to England, and then refined.

The Anaconda Mining Company purchased from the Westinghouse Company some time ago seven 360 horse-power generators, of an output of 3,600 amperes each at 75 volts. The machinery of the Boston Company will be driven by turbines from the waters of the Great Falls. The generators will be directly connected with the turbines. There are two of them, the largest ever made, each one of 1,100 horse-power, at an output of 4,500 amperes and 180 volts. These machines, as shown in the accompanying engraving, are shipped in four freight cars, while the others are filled with the detail apparatus, such as switchboard appliances, etc. The Westinghouse electric locomotive handled the train in the yards of the company, at Brinton, Pa.

SUSSMANN'S ELECTRIC MINERS' LAMP.

AN electric lamp has been recently introduced in England which has been tested with very satisfactory results by both mining and electrical engineers. The novelty of this apparatus lies entirely in the battery which feeds it, as the lamp itself is of the ordinary type. The battery plates are made by incorporating India-rubber and powdered pumice stone with the active material, by means of which additions the material is more firmly attached to the plate and at the same time greater porosity is obtained. In the second place, a solid electrolyte is used which is said to have considerably less internal resistance than others hitherto employed. This is made by adding finely powdered and dried cellulose to the sulphuric acid, the effect of the mixture being that the cellulose swells up and forms with the acid a stiff, thick paste. The battery as made measures over all 2¾ inches square by 8 inches high and weighs 3½ pounds. It will take a charge of about seven ampere-hours at six volts, making the energy of the charge 42 watt-hours. The average current during discharge is 0.53 ampere, and the variation in volts, toward the end of the discharge, is less than 5 per cent. The lamp can, therefore, be depended on to give an excellent and steady light for quite ten hours. It is being made by the Edison & Swan Company.

EDWARD P. SHARP.

Among the dealers in second-hand electrical supplies who have some real bargains at this time may be mentioned Mr. Edward P. Sharp, of Buffalo. His stock includes generators, motors, controllers, motor bearings, armatures, line material, etc. Everything is guaranteed to be in first-class condition and at prices to suit the closest buyer.

NEW YORK NOTES.

MESSRS. M'LEOD, WARD & CO., Thames and Greenwich streets, are meeting with a brisk demand for their Kinsman desk lights and portables. They also manufacture the well-known Ward spark arresters and safety insulators.

MESSRS. HUEBEL & MANGER, 286 Graham street, Brooklyn, N. Y., are running ten hours a day, with a force of about seventy men, turning out their many specialties, such as electric bells, push buttons and all kinds of household supplies. They report large orders, especially for their well-known skeleton bell, "Style F," and their iron box bells. Prospects look favorable for summer trade, their Mr. McChesney having recently returned from a very successful business trip.

THE old, well-known firm of Walsh's Sons & Co., Newark, N. J., are offering a promiscuous lot of dynamos, battery jars, lamps and other electrical goods both new and secondhand. This firm as dealers have exceptional facilities for handling and storing heavy electric machinery and supplies of all kinds, which puts them in a position to offer unusual bargains to the purchaser. Those interested would do well to follow up their advertisement from week to week in our "For Sale" columns.

THE HOGAN BOILER COMPANY are accumulating orders which will require a large addition to the company's manufacturing plant. Among them may be mentioned a second order for a 250 horse-power boiler for Mr. McDonald, the contractor for the Jerome Park reservoir, which came unsolicited and is to be credited to the merits of the boiler already installed. They have also received a second order from the Franklin Electric Illuminating Company, of Sea Cliff, L. I., and another of a 200 horse-power boiler for the National Starch Company, Glen Cove, L. I.

THE JOHN WENNSTROM COMPANY, 41st street, between 3d and 4th avenues, Brooklyn, N. Y., whose advertisement appears on another page, are the only large firm in this country making a specialty of manufacturing jewels for meters and all kinds of testing instruments. Their factory is running very busy also on diamond tools for all purposes and turning out shaving knives, recorders and reproducers for both the phonograph and graphophone. The factory is excellently equipped and arranged, and does great credit to Mr. John Wennstrom, the president of the company, who has been in the business for the past twenty years.

MR. CHAS. WACHTEL, proprietor of the Wachtel Electrical Manufacturing Company, has been in the electrical business for the past twenty-eight years. Since 1890 he has his factory located corner Hamilton street and New Jersey Railroad avenue, Newark, N. J., and reports a steadily growing business. Mr. Wachtel is the manufacturer of "The Leader" dynamo, which can be used for lighting or power purposes, also fans, fan motors and the "Wachtel" ceiling fan, which is highly recommended requiring, it is claimed, less power at very high speed than any other fan in the market. Mr. Wachtel is a manufacturer of other electrical specialties, and solicits repair work, winding armatures and furnishing parts for motors of all kinds, tools and dies for every purpose, etc., etc.

WESTERN NOTES.

THE BROWN HOISTING AND CONVEYING MACHINE COMPANY have just sold Messrs. E. D. Smith & Co., contractors, to be used on the work of extending the wheel pits of the Niagara Falls Power Company to accommodate seven more 5,000 horse-power turbines, two of their standard ten-ton locomotive cranes, fitted with extra large drums to take the great length of rope that will be required in hoisting out of the wheel pits.

THE WESTERN ELECTRIC COMPANY, Chicago, have removed their general offices from their old location on South Clinton street ,to the large new eight-story building which they recently erected on South Jefferson street, as an addition to their large factory, the location of the new building being also between West Jackson and Van Buren streets, but nearer the latter street. All the buildings are connected, and their factory is now one of the largest in the country.

THE CHICAGO BELTING COMPANY, Chicago, have recently completed the largest leather belt that has ever been made. It is 3 ply in thickness, 7 feet in width, 150 feet long, and weighs, 3,200 pounds. In its manufacture the selected portions of 450 oak-tanned hides picked from over 5,000 skins were used. There is not a stitch or rivet in the whole belt, glue being used exclusively as the adhesive substance. It has been purchased by the Louisiana Electric Light Company, New Orleans, La., where it will be attached to a 2,000 horse-power Atlas engine.

Department News Items will be found in advertising pages.

5711 Sheet 1.

COPPER WIRE TABLE, B. & S. GAUGE. A.

American Wire Gauge, B. & S.	Diameter in Inches.	Area in Circular Mils. Diam.²	Lbs. per Foot.	Lbs. per Ohm @ 20° C.	Feet per Lb.	Feet per Ohm @ 20° C.	Ohms per Lb. @ 20° C.	Ohms per Foot @ 20° C.	Under-writer's Rules Allow: Current Carrying Capacity. Concealed Work. Amp.	Under-writer's Rules Allow: Current Carrying Capacity. Open Work. Amp.
0000	0.460	211,600	0.6405	13,090	1.561	20,440	0.00007639	0.00004893	218	312
000	0.4096	167,800	0.5080	8,232	1.969	16,210	0.0001215	0.00006170	181	262
00	0.3648	133,100	0.4028	5,177	2.482	12,850	0.0001931	0.00007780	150	220
0	0 3249	105,500	0.3195	3,256	3.130	10,190	0.0003071	0.00009811	125	185
1	0.2893	83,690	0.2533	2,048	3.947	8,083	0.0004883	0.0001237	105	156
2	0.2576	66,370	0.2009	1,288	4.977	6,410	0.0007765	0.0001560	88	131
3	0.2294	52,630	0.1592	810.0	6.276	5,084	0.001235	0 0001967	75	110
4	0.2043	41,740	0.1264	509.4	7.914	4,031	0.001963	0.0002480	63	92
5	0.1819	33,100	0.1002	320.4	9.980	3,197	0.003122	0.0003128	53	77
6	0.1620	26,250	0.07946	201.5	12.58	2,535	0.004963	0.0003944	45	65
7	0.1443	20,820	0.06302	126.7	15.87	2,011	0.007892	0.0004973	—	—
8	0.1285	16,510	0.04998	79.69	20.01	1,595	0.01255	0.0006271	33	46
9	0.1144	13,090	0.03963	50.12	25.23	1,265	0.01995	0.0007908	—	—
10	0.1019	10,380	0.03143	31.52	31.82	1,003	0.03173	0.0009972	25	32
11	0.09074	8,234	0.02493	19 82	40.12	795 3	0 05045	0.001257	—	—
12	0.08081	6,530	0.01977	12.47	50.59	630.7	0.08022	0.001586	17	23
13	0.07196	5,178	0.01568	7.840	63.79	500.1	0.1276	0 001999	—	—
14	0.06408	4,107	0.01243	4 931	80.44	396.6	0.2028	0.002521	12	16
15	0.05707	3,257	0.009858	3.101	101.4	314.5	0.3225	0.003179	—	—
16	0.05082	2.583	0.007818	1.950	127.9	249.4	0.5128	0 004009	6	8
17	0.04526	2,048	0.006200	1 226	161 3	197 8	0.8153	0.005055	—	—

The American Institute of E. E. Tables of Copper Wire were used for the above.

5715 Sheet 1.

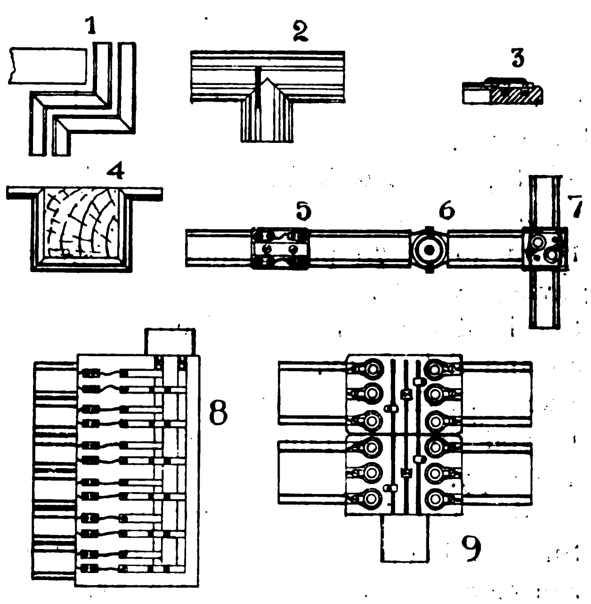
GALV. IRON WIRE TABLE ON 110 VOLTS. B.

No. Washburn & Moen Gauge.	Equiv. Single Wire. D in Mils.	Equiv. Single Wire. Sect. Area in Square Mils.	Equiv. Single Wire. D² in Cir. Mils.	Iron Frame. Safe Capacity.	Iron Frame. Resistance necessary in circuit for safe capacity.	Iron Frame. Length and Resistance necessary to drop to next size wire. Resist.	Iron Frame. Length and Resistance necessary to drop to next size wire. Length	Ohms per Foot (Legal).	Feet per Ohm.	Pounds per Foot.	Logarithm of Column Ohms per Foot.
3 No. 4 & 1 No. 6	434	148.236	188,356	200	.55	.029	59.5	.000488	2049	.500	—4.688420
2 No. 4 & 1 No. 5 & 1 No. 6	425	142 167	180,625	190	.579	.032	63.5	.000504	1984	.4792	—4.702431
4 No 5	414	134,616	171,396	180	.611	.036	66.6	.000540	1852	.4540	—4.732394
3 No. 5 & 1 No. 7	400	125,568	160,000	170	.647	.040	69.1	.000579	1727	.4236	—4.762679
3 No. 4	390	119,283	152,100	160	.687	.046	75.6	.000607	1647	.4026	—4.783189
3 No. 4	390	119,283	152,100	150	.733	.052	85.6	.000607	1647	.4026	—4.783189
3 No. 5	359	100,962	128 881	140	.785	.061	84 7	.000720	1389	.3405	—4.857332
2 No. 6 & 1 No. 4	353	97,667	124.609	130	.846	.071	95.7	.000742	1348	.3288	—4.870404
2 No. 6 & 1 No. 5	341	91,560	116,281	120	.917	.083	104.7	.000793	1261	.3081	—4.899273
2 No. 4	318	79,522	101,124	110	1 000	.100	109.9	.000910	1098	.2684	—4.959041
1 No. 4 & 1 No. 5	306	73,415	93,636	100	1.100	.122	124.5	.000988	1012	.2477	—4.994757
2 No. 5	293	67,308	85,849	90	1.222	.153	141.6	.001080	925	.2270	—3.033424
1 No. 5 & 1 No. 6	262	62,607	79,524	80	1.375	.196	169.0	.001157	864	.2108	—3.063333
2 No. 6	272	57,906	73,984	70	1.571	.262	208.7	.001255	797	.1946	—3.098644
2 No. 7	250	49,211	62,500	60	1.833	.145	97.9	.001480	675	.1662	—3.170262
4	225	39,761	50,625	55.6	1.978	.337	185.0	.001820	549	.1342	—3.260071
5	207	33,654	42 849	47.5	2.315	.846	391.6	.002160	463	.1135	—3.334454
6	192	28,953	36,864	34.8	3.161	.493	196.4	.002510	398	.0973	—3.399674
7	177	24 606	31,329	30.1	3.654	.481	162.5	.002960	337	.0831	—3.471292
8	162	20,612	26,244	26.6	4.135	.606	171.6	.003530	283	.0695	—3.547775
9	148	17,203	21,904	23.2	4.741	.839	198.3	.004230	236	.0580	—3.626340
10	135	14,314	18,225	19.7	5.580	1.210	237.1	.005080	196	.0483	—3.705864
11	120	11,310	14,400	16 2	6.790	1.123	174.1	.006130	155	.0383	—3.808211
12	105	8,659	11,025	13 9	7.913	1.576	188 5	.0.8400	119	.0292	—3.924279
13	92	6,648	8.464	11.6	9.489	2.361	206.8	.010940	91.4	.0224	—2.039017
14	80	5,027	6,400	9.28	11.850	3.950	274.0	.014470	69.1	.0169	—2.160469
15	72	4,071	5,184	6.96	15.800	3.160	277.0	.017860	56.0	.0138	—2.251881
16	63	3.117	3,969	5.8	18.960	6.681	286.0	.023330	42.8	.0110	—2.367915
17	54	2.290	2,916	4.29	25.641			.031760	31.4	.00868	—2.501880

5725 Sheet 5.

WIRING IN MOLDING. B.

Accompanying engraving at 1 shows method of making an offset with molding around an obstruction; 2 shows method of taking branches from molding where cut-out is not required; 3 is cross-section of 2 showing how the wires of different polarity are crossed; 4 shows method of get-



ting around beams; 5 shows the method used in placing a main line cut-out; 6 a ceiling cut-out or rosette; 7 a branch block; at 8 is shown methods of bringing moldings to a panel-board, and at 9 is shown the method of assembling three-wire double branch cut-outs where moldings are used.

5762 Sheet 1.

TEST ON RAIL BONDING. B.

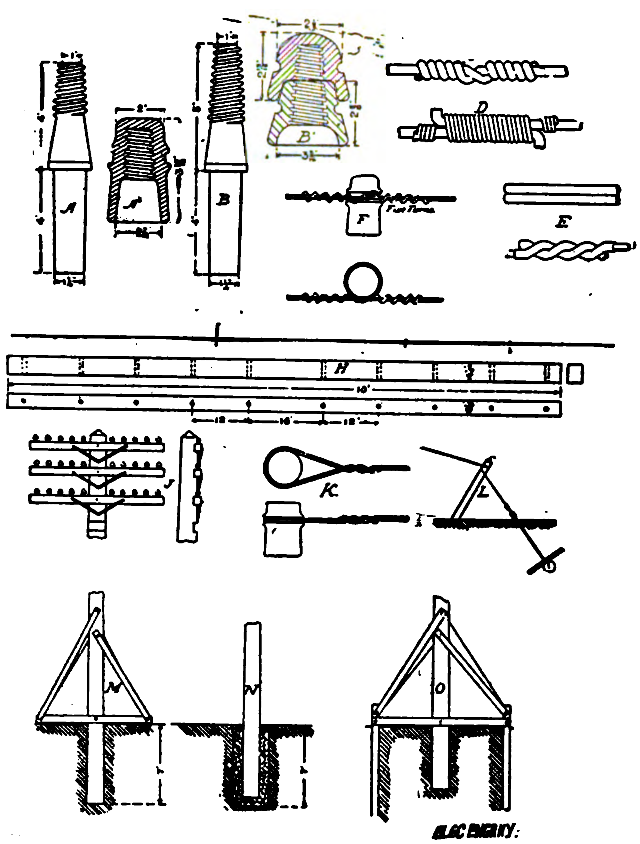
Characteristics per Mile, Double Track.

These estimates were made, not taking into account any earth leakage, the same as if the ground was frozen and giving relative electrical efficiency of some of the different methods of bonding.

Case.	Description.	Total R of Rails. Ohms	Total R of Rail Bonds. Ohms.	Total R of Track Circuit. Ohms.	Fall of Potential for 900 amp. Volts.	Total Energy expended thus in Track Circuit. Watts.	Cost of such per Year at $100 per Kilowatt. Dols.	Approx. Cost of Track Circuit Material. Dols.
	70 lb. Rail Double Track.							
1.	No. 4 copper bonds, connectors and two No. 0 copper supplementaries	.0086	.0335	.0362	7.24	1.448	144.	700.
2.	No. 4 copper connectors to rail ends, two No. 0 copper supplementaries	.0086	.0671	.0586	11.72	2.344	234.	700.
3.	36 inch No. 0 iron bonds, single. No supplement	.0086	.0796	.0882	17 64	3.528	352.	90.
4.	36 " " 0 " " double " "	.0086	.0398	.0484	9.68	1.936	193.	180.
5.	36 " " 0 copper bonds, single. " "	.0086	.0133	.0218	4.36	.872	87.	180.
6.	12 " " 0 " " " " "	.0086	.044	.0130	2.60	.520	52.	115.
7.	36 " " 00 " " " " "	.0086	.0105	.0191	3.82	.764	76.	200.
8.	12 " " 00 " " " " "	.0086	.0035	.0121	2.42	.484	48.	180.
9.	36 " " 000 " " " " "	.0086	.0083	.0169	3.38	.676	67.	220.
10.	12 " " 000 " " " " "	.0086	.0027	.0113	2.26	.452	45	150.
	90 lb. Rail Double Track.							
11.	No. 4 copper connectors to rail ends, four No. 0 supplementaries	.0067	.0335	.0306	6.12	1.224	122.	1250.
12.	12 inch No. 0000 copper bonds, double. No supplementary	.0067	.0011	.0078	1.56	.312	31.	432.

J. J. McTighe. Paper read before New York State Street Railway Association, September, 1893.

5751. Sheet 1.	TELEPHONE POLE LINE CONSTRUCTION.	B.



5751. Sheet 2.	TELEPHONE POLE LINE CONSTRUCTION.	B.

THE poles to be Michigan or Canadian cedar and of best quality live green cedar wood; butts cut squared at both ends, reasonably straight and well proportioned from butt to top and peeled, and knots trimmed close. The cross-arms to be well seasoned, straight grained Norway pine, thoroughly painted with brush and covered with two coats of Prince's metallic paint, consisting of seven pounds mixed with one gallon of pure linseed oil. All pins to be the best quality sound clear split locust, free from knots and sap-wood; standard pin to be 1¼ inches in diameter, as shown at A, No. 5751, Sheet 1. The transposition pin 1¼ inches in diameter, is shown at B; pins to be nailed to cross-arms with sixpenny galvanized iron wire nails driven straight from the middle of the side of the cross-arm as shown at H; pins to be spaced on the cross-arms, the two nearest the pole 16 inches apart and equidistant from the centre of pole; all others 12 inches apart. The standard cross country pole now consists of 35-foot pole having an ultimate capacity for four ten wire cross-arms. The gains for all cross-arms to be cut 4¼x½in. deep, before the pole is erected.

Line joints are made in galvanized wire; American Telegraph splice shown at C; D shows splice for copper wire; E shows the McIntire joint, which consists of two small copper tubes brazed together into which the ends of the wires are inserted, and the tubes twisted around each other; at F is shown top and side view of the proper manner of tying line wire to insulator, where copper wire is used.

LINE LOCATION:—Measure off and place stakes every 130 ft., locate poles as near stakes as possible; the heaviest poles should be placed on corners; the strongest and best looking poles distributed in thickly populated districts. A ⅝-inch hole should be bored through the centre of each gain at the time the cross-arm is placed in position. In a 30-foot pole line, on straight lines, the poles should be set in the ground 6 feet and on curves 6½ feet; the holes to be sufficiently large at the bottom to allow of using iron tampers all around the pole. On straight lines where poles

(*Continued on* 5751, *Sheet* 3.)

5751. Sheet 3.	TELEPHONE POLE LINE CONSTRUCTION.	B.

are equidistant, the cross-arms should be placed on alternate sides of the pole. At J, (5751, Sheet 1) is shown the method of roofing or champhering the top of the pole, which should be painted with same mixture as used for cross-arms; also method of bracing cross-arms with galvanized iron braces 1¼x28 in. long.

Clear glass insulator known as Standard pony insulator to be used and made as shown at A¹; transportation insulator also made as shown at B¹; at K is shown the method of dead ending and using ½ length of McIntire connector to secure end. At L is shown accepted method of anchoring the guy rod for a stub used for bracing of poles at curves and corners; M, N and O show methods of securing artificial foundations where ground is too soft to allow of proper tamping. To prevent line strains, poles are guyed by attaching guy wires near the bottom of the pole taking some of the strain to the top of the next pole. This parallel guying is sometimes carried back for three or four poles to distribute along the pole line a strain caused by a change of direction of the line.

Hard drawn copper line wire is now used for long distance telephone lines; the conductivity of copper is six times higher than iron; same line resistance will have ½ the weight with copper, and the speed of transmission is higher. The life of copper, especially near cities and on sea coast lines, is a great deal longer than galvanized iron.

The requirements of hard drawn copper wire for telephone work are as follows: For instance, take No. 8 B. W. G., diameter .1650 inches; maximum diameter allowed, .1660 inches, minimum diameter, .1640 inches; weight in lbs. per mile, 435.8; maximum weight, 441.1; minimum weight 430.5. A 200-lb. wire bar should draw a length of 2600 feet maximum; 1860 feet minimum; weight in lbs., maximum, 215; minimum, 153. Tensile strength 62,500 lbs. per sq. inch. Breaking weight required, maximum, 1335 lbs.; minimum, 1320 lbs. with elongation in 5 feet of 1 per cent. and to allow thirty twists in 6 inches without breaking. Conductivity required 97 per cent.; minimum to pass, 96 per cent.; pure copper taken at 100 per cent.

5714 Sheet 1.	CONDUCTIVITY OF ALLOYS.	B.

IN mixing two or more metals together, there has been found no definite law connecting the conductivity of the metals before mixing and the resultant alloy, but generally it has been found that the conductivity is below the mean of the metals entering into the mixture.

It will be seen by the tables given below, of the conductivity of alloys, that the combination of copper and zinc does not lead to as great a reduction in conductivity of the alloy as the combination of copper and tin. A column of figures is also given, with copper taken at twenty cents (20c.) per lb., and from this the value of the different compositions, as conductors, has been computed, when used for conductivity only. Of course, there are other considerations, such as cost of working and casting, which modify the price of the finished product, but it shows clearly that wherever copper can be substituted for composition, which is figured at a given current density, a large saving over the use of most any of the compositions can be effected. In table No. 3, the conductivities of some unusual alloys are given for comparison.

TABLE No. 1.

COPPER.	ZINC.	CONDUCTIVITY COMP'D WITH SILVER AS 100,0° C.	VALUE COMPARED WITH PURE COPPER AS CONDUCTOR @ 20c. PER LB.
88.89%	11.11%	25.5 (Wiedemann.)	78.40
86.67%	13.33%	30.9 "	64.60
82.54%	17.5%	29.2 "	68 40
75.00%	25.00%	22.08 "	81.40
73.30%	36.70%	22.27 "	89.80
67.74%	32.26%	25.4 "	78.60
	100.00%	27.39 (Matthiessen.)	73.00

Brass is usually made in the proportion of ⅓ zinc and ⅔ copper by weight.

TABLE No. 2.

COPPER.	TIN	CONDUCTIVITY COMP'D WITH SILVER AS 100,0° C.	VALUE COMPARED WITH PURE COPPER AS CONDUCTOR @ 20c. PER LB.
98.59%	1.41%	62.46 (Matthiessen.)	32.00
93.98%	6.02%	19.68 "	101.60
90.30%	9.70%	12.19 "	164.00
89.70%	10.30%	10.21 "	195.80
88.39%	11.61%	12.10 "	165.20
87.65%	12.35%	10.15 "	197.00
85.09%	14.91%	8.82 "	204.00
16.40%	83.60%	12.76 "	159.80
	100.00%	11.45 "	174.60

TABLE No. 3.

COPPER.	ZINC.	TIN.	LEAD.	SILVER.	PURE COPPER TAKEN @ 100%
88.5%	6%	4%	1½%	....	23.4%
99.3%	....	....	....	0.63%	89.0%

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ALPHABETICAL INDEX TO ADVERTISEMENTS.

CLASSIFIED INDEX TO ADVERTISEMENTS.

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"Chloride Accumulator"
REGISTERED SEPTEMBER 11, 1894.

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Has been demonstrated by

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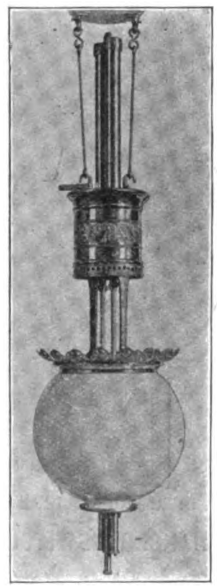

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No Energy Wasted in Heating Large Carbons.
Greater Volume of Light.
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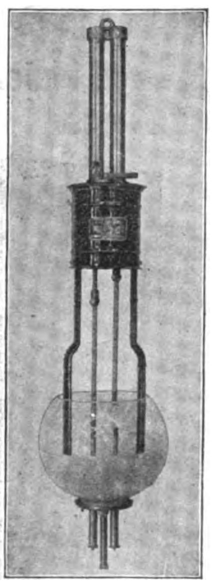

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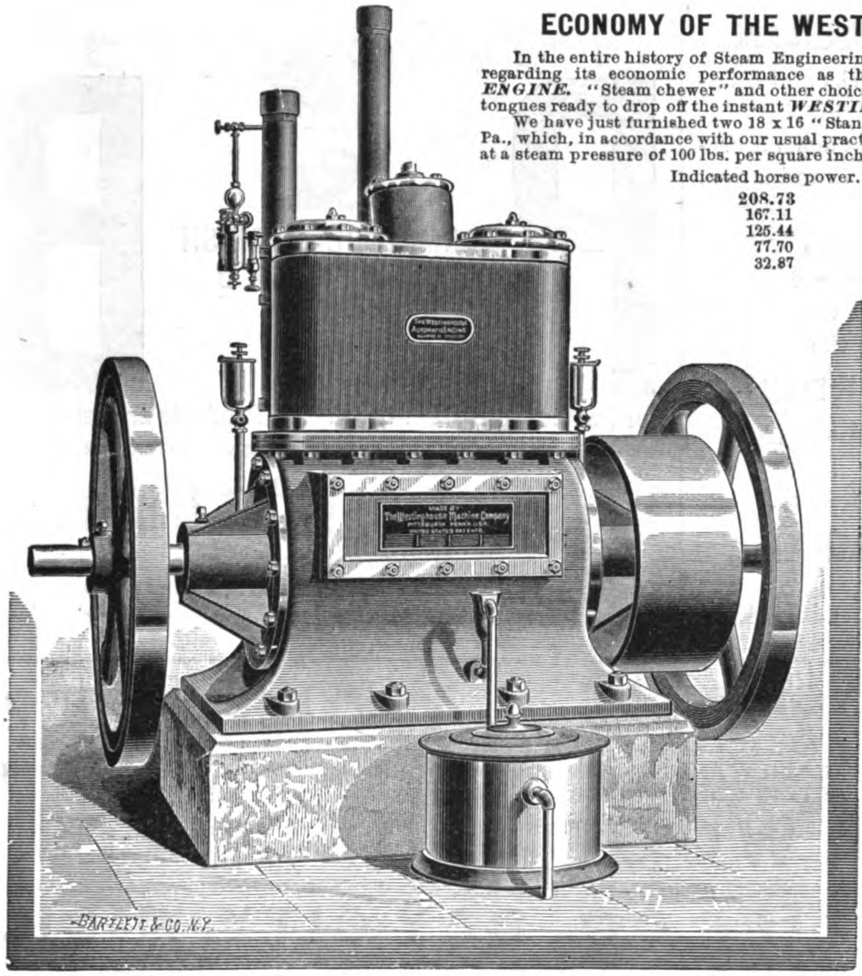

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In the entire history of Steam Engineering, probably no engine has been so industriously slandered regarding its economic performance as the *WESTINGHOUSE "STANDARD" AUTOMATIC ENGINE.* "Steam chewer" and other choice epithets, are always balanced on the tip of our competitors' tongues ready to drop off the instant *WESTINGHOUSE "STANDARD" ENGINE* is mentioned.

We have just furnished two 18 x 16 "Standard" engines to the Summit Branch R. R. Co., Wilkes-Barre, Pa., which, in accordance with our usual practice, were submitted to careful economy tests before shipment at a steam pressure of 100 lbs. per square inch, with the following results:

Indicated horse power.	Water per I. H. P. per hour.
208.73	26.68
167.11	28.05
125.44	28.24
77.70	31.40
32.87	40.50

There is no other single valve Automatic engine made which can duplicate the above results, and we believe it will bother the best four valve simple non-condensing engine to meet this performance over such a wide range of load.

We do not ask our customers to take the statement of any one in regard to the economy of our engines. Any purchaser may send his own expert and test his engine before it is shipped, and before he has incurred the expense of installation. No one else makes a similar offer. When we make a statement about the economy of our engines we mean it. That's the difference.

Send for little books on "Economy Guarantees" and "Testing."

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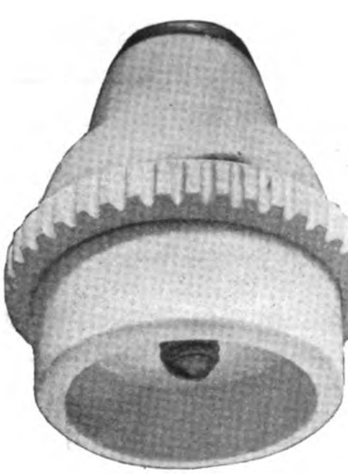

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Peru Pony Wall Receptacle, made for T.-H. or Westinghouse systems, and with or without ring for supporting shade holder.

The quality, workmanship and simplicity for wiring of our goods cannot be beaten. Write for quotations.

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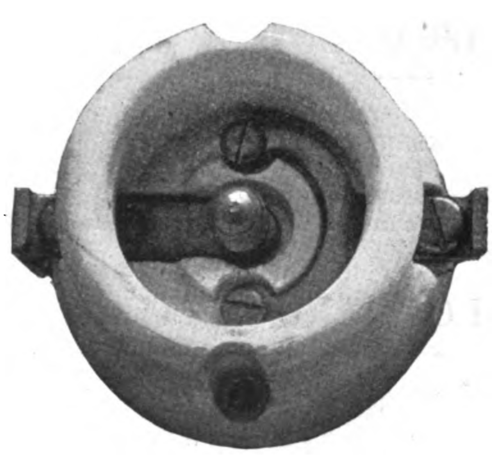
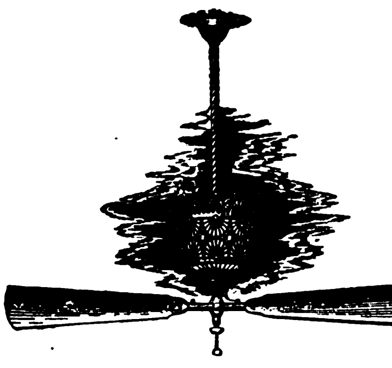


Ariel Alternating Current Fan Motor.

IS SHOWN IN THE ILLUSTRATION



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NEW YORK. CHICAGO.

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TENDERS WANTED FOR TELEPHONE SERVICE

FOR THE CITIZENS OF TORONTO.

Sealed proposals will be received by mail, addressed to the Chairman of the Board of Control of the City of Toronto, up to the hour of 5 p. m., on the 15th day of July, 1896, for the privilege of constructing and maintaining a telephone services for the citizen of Toronto, for a term of five years or longer.

Parties tendering are required to supply their own specifications and plans. Further information may be obtained upon application to the undersigned.

For the information of tenderers, it may be necessary to state that the population of Toronto is 200,000.

R. J. FLEMING,
CHAIRMAN BOARD OF CONTROL.

CITY HALL, TORONTO.
June 11th, 1896.

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Stanley,	65c. per light
Westinghouse,	45c. " "
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MISCELLANEOUS.

POCAHONTAS, VA.—The Southwest Virginia Improvement Company is putting in its machine shops an extensive electric power plant.

BALTIMORE, MD.—The subway commission has decided to accept the bid of the Standard Company to lay cables in sections 2 and 3 of the police and fire subway system, provided some minor changes can be made in the apparatus furnished without changing the specifications. The company's bid was $13,009.

ELECTRIC RAILWAYS.

BALTIMORE, MD.—The council on June 1 passed an ordinance authorizing the Falls Road Electric Railway Company to construct an electric line out the Falls Road, from Lafayette and Maryland avenues, to the city limits.

SPRINGFIELD, VT.—The town of Springfield has voted to bond itself for $30,000 toward building an electric road between that place and Charleston. The estimated cost of construction and equipment is $100,000.

FINANCIAL.

GREAT FALLS, MONT.—The stockholders of the Great Falls and Lewistown Telephone Company have declared a dividend of 16 per cent. on the capital stock.

PITTSBURG, PA.—The Westinghouse Electric and Manufacturing Company has declared a quarterly dividend of 1¾ per cent. upon the preferred stock, payable July 1. Transfer books close June 20 and reopen July 2.

BROOKLYN, N. Y.—The Edison Electric Illuminating Co., of Brooklyn, has declared a quarterly dividend of 1½ per cent., payable July 15. Books close June 30 and reopen July 16.

BALTIMORE, MD.—The first branch of council has passed the ordinance providing for the issuance of $1,000,000 bonds to construct a system of subways for electric wires.

BOSTON, MASS.—The American Bell Telephone Company has declared a quarterly dividend of $3, and an extra dividend of $1.50, payable July 15, to stock of record June 30. This makes extra dividends of $3 thus far for 1896, which is the same as last year, or at the rate of $15 per annum.

See further page xiv.

ELECTRIC LIGHT.

CANNON FALLS, MINN.—Cannon Falls will have an electric light plant. The village has granted a five years' franchise to D. and J. Valentine, who are now at work on the enterprise.

BLOOMSBURG, PA.—Bloomsburg has closed a five-year electric lighting contract for $80 a light. Pottsville pays $95 a light.

CATONSVILLE, MD.—The owners of the Catonsville Short-Line Railroad are considering a plan to operate electric trolley cars for carrying passengers and trains drawn by steam locomotives for hauling freight over the road. The line is owned by the Baltimore and Catonsville Construction Company and is operated by the Pennsylvania Railroad Company under a lease.

SCRANTON, PA.—The Citizens' Street Railway Company of Lackawanna County, capital $200,000, has been chartered to build a line through the principal streets of Scranton and Dumore, a distance of thirty miles. The directors are William L. Connellll, Plummer Page, Charles H. Schadt, Patrick J. Horan and Henry H. Archer, Scranton.

See further page xvii.

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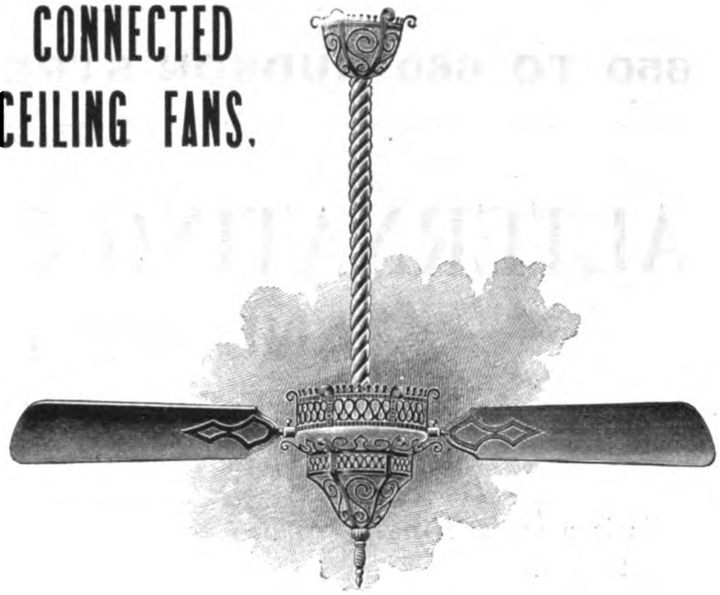

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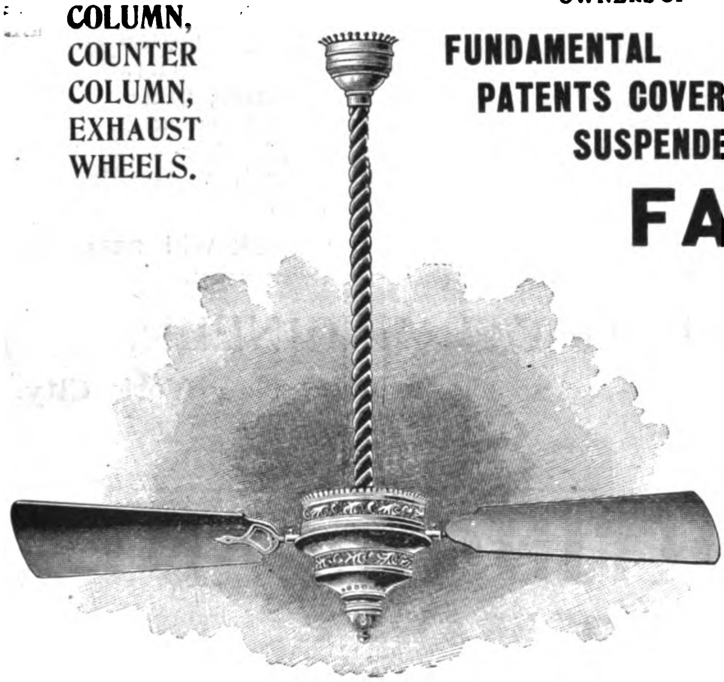

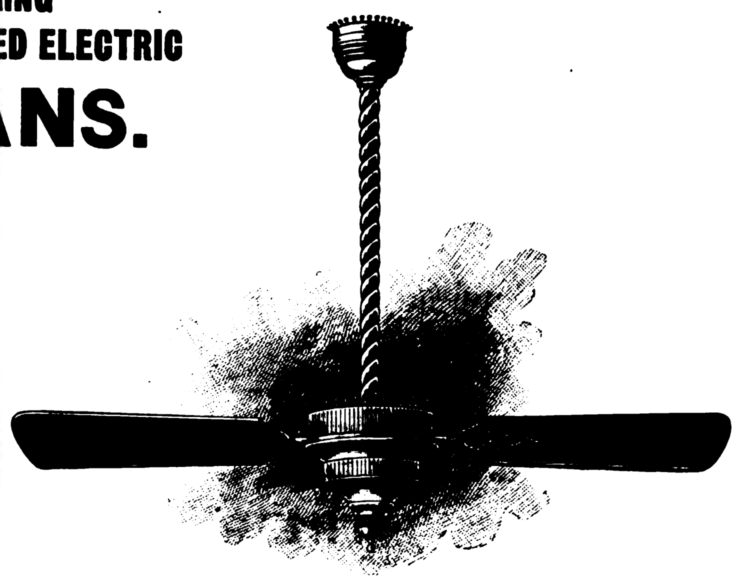

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MISCELLANEOUS.

NEW YORK, N. Y.—The Acme Electric Lamp Company has been formed with $50,000 capital.

OLD TOWN, ME.—One of the electric launches, which have been purchased by the B. O. and O. Street Railway Company to be run on the Penobscot, has arrived. The launch is 35 feet long, 7 feet wide and has a capacity of 35 or 40 passengers. It is identical with those in use at the World's Fair, and was built at a cost of $2,700.

See further, page xxiii.

TELEPHONE.

PORTERVILLE, CAL.—The Mount Whitney Telephone and Power Company has ben formed to construct and operate a telephone line in Tulare County. Principal place of business, Porterville, Tulare County. Capital stock, $2,000, all of which has been subscribed. Directors, J. M. Gilstrap, Daunt; James Bursell, Globe; W. E. Sprott, A. M. Lumley, H. F. Brey, Porterville; Charles Rankin, Lindsay, and J. Sub. Johnson, Visalia.

MILWAUKEE, WIS.—Ripon Telephone Company; capital, $1,000; incorporators, M. S. Chittenden, L. E. Hall, G. F. Horner, H. P. Cody and Louis Pynch.

PARKER, S. D.—Articles of incorporation have been filed for the Houts Automatic Telephone Switch Company, of Parker, with a capital stock of $50,000; incorporators, W. A. Houts, F. E. Hayward, C. G. Pratt, B. W. Kumler, Vale P. Thielman

CENTREVILLE, WIS.—The extension portion of the Trempealeau telephone line, from Centerville to Arcadia, was sold by C. S. Utter to a syldicate of five citizens of Arcadia. The line was nearly completed when the sale ook place. The syndicate will build to Indèpendence, Whitehall, Blair, Waumandee, Montana and from Centerville to Bluff Siding, connecting with the Winona Telephone Company.

ROCHESTER, MINN.—Articles of incorporation of the Rochester Telephone Company have been filed with the secretary of state. The capital stock is placed at $20,000.

RENVILLE, MINN.—The Renville Consolidated Telephone Company has increased its capital stock to $10,000 and will at once erect a line from Renville to Olivia.

ORANGE, N. J.—The ordinance granting the New York and New Jersey Telephone Company permission to place its wires in underground conduits, has been passed.

NEW PORTLAND, ME.—The New Portland and Farmington Telephone Company has been organized at New Portland for the purpose of constructing and operating a telephone line from New Portland to Farmington, with $1,200 capital stock, of which $1,000 is paid in. The officers are: President, John Metcalf, of New Portland; treasurer, W. J. Trefethen, of New Portland.

YORKVILLE, S. C.—W. B. Moore has applied for a franchise for a telephone system.

See further, page xxiv.

ELECTRIC RAILWAYS.

NEW ORLEANS, LA.—An electric line, from the corner of Napoleon and St. Charles avenues to Metairie Cemetery, thence to the West End, is in contemplation by a number of prominent and wealthy citizens of New Orleans, who propose to give the uptown residents an electric route to the lake.

JACKSONVILLE, FLA.—The Panama Park Company has petitioned for leave to construct and operate an electric line.

ELGIN, ILL.—The electric road which is to connect Elgin and Aurora is expected to be finished as far as Geneva by June 20 and will be opened for business then. It is to be finished to Aurora this fall.

SKOWHEGAN, ME.—The railroad commissioners have made an official trip over the electric railway of the Somerset Traction Company, and have accepted the line as far as Madison Centre, a distance of five miles from Skowhegan. The balance of the road, from Madison Centre to Madison village, will be finished in a few weeks.

INDIANAPOLIS, IND.—The Citizens' Street Railroad Company, which now operates 100 miles of road, began an extension of its present line on May 25. The new line will run through Ninth street, Forest avenue, Twenty-second street, Greenwood avenue and Bellefontaine street.

MOUNDSVILLE, W. VA.—Work on the completion of the Moundsville, Benwood and Wheeling Railroad, from Moundsville to Benwood, a distance of thirteen miles, has been begun by Receiver Howard Hazlett, of Wheeling.

PITTSBURG, PA.—Construction work on the new Pittsburg and Mansfield Railway is to be commenced at once. During the past two years only enough work has been done to save the charter. The cost of the road is estimated at $1,000,000, a large part of which will be expended on the bridge and the tunnel. The work of changing the Fifth avenue road from cable to electric line began June 1. Nearly 1,000 cars, each equipped with 50 h.-p. motors, have been ordered. It is expected to complete the transformation before October 1.

See further, page xxvi.

ELECTRIC LIGHT.

NEWARK, N. J.—A verdict was rendered in the Circuit Court for $253.37 in favor of the plaintiff in the suit of the Newark Electric Light and Power Company against the Merchants' Express and Transportation Company.

PUEBLO, COLO.—THE Pueblo Electric Light and Power Company, capital $5,000, has been formed. H. Eugene Chubbuck, Irving Hall and Albert E. Pattison, incorporators.

PAWTUCKET, R. I.—The contract for putting an electric light plant at the No. 3 jumping station has been awarded to Duffy Brothers.

SILVER LAKE, N. J.—The contract for lighting the Silver Lake district with electric lights was awarded to the Kearney Electric Light Company.

AUGUSTA, ME.—The Kennebec Light and Heat Company are improving the facilities at their plant in Augusta by the introduction of a large turbine wheel.

ASBURY PARK, N. J.—The Atlantic Coast Electric Light Company has been incorporated by John E. Comins, Arlington, N. J.; Arthur D. Chandler, Orange, N. J.; John B. Summerfield, Brooklyn, N. Y. Capital stock, $50,000

NORTH ADAMS, MASS.—The North Adams Gas Company has made arrangements with the Fitchburg Railway to furnish the electric current to light the Hoosac tunnel. It will take a current of 1,100 volts, and to meet this extra demand the gas company will put in another boiler and substitute an engine of 400 horse-power for one of 350 horse-power. This will place the gas company in the position of having the largest electric plant west of the Connecticut River in Massachusetts.

MILWAUKEE, WIS.—The council committee on street lights decided to recommend the adoption of a resolution calling upon the city engineer to prepare estimates for a centrally located lighting plant.

Lafayette, Colo.—E. Cannon, who recently received a franchise to erect and operate an electric plant in Lafayette, has ordered his dynamos and other machines, and will commence the erection of his house at once.

BERKELEY, CAL.—The Berkeley Electric Lighting Company is about to erect a new $20,000 electric station on its property at the corner of Third street and Channing way, West Berkeley.

DECATUR, ILL.—Jefferson G. Millard and R. W. Hight have applied for a receiver for the Municipal Electric Company, alleging mismanagement and failure to make it yield best returns. The petitioners hold a mortgage on the plant, which is worth $75,000. Large improvements have recently been made.

MISCELLANEOUS.

PEORIA, ILL.—The Eagle Electric Works, Peoria, have been incorporated; capital stock, $5,000; incorporators, Frank Thone, Charles F. Nash, and Peter J. Bourscheldt.

KNOB RUN, O.—A complete electrical equipment is to be put in a large coal mine here.

PARKERSBURG, W. VA.—J. Blyth, a Pittsburg capitalist, has completed the purchase of 1,000 acres of valuable coal and timber land on the east side of the Elk River, about twenty miles above Charleston. The coal will be mined by machinery, using electricity as power.

NEW YORK, N. Y.—The X-Ray Manufacturing and Exhibition Co., of New York City, capital $10,000, has been incorporated. Directors, Cyrus O. Baker, of New York City; John A. Seely, Edward F. Peck, P. J. Bennett, of Brooklyn, and Fremont Wilson, of Yonkers.

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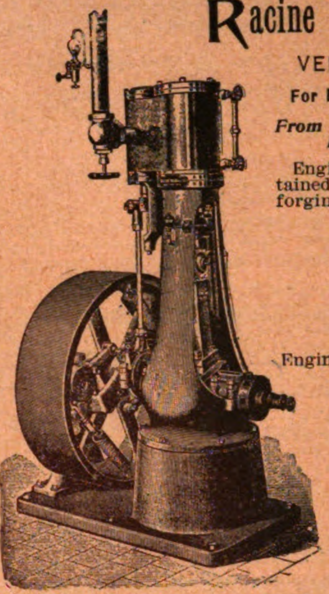

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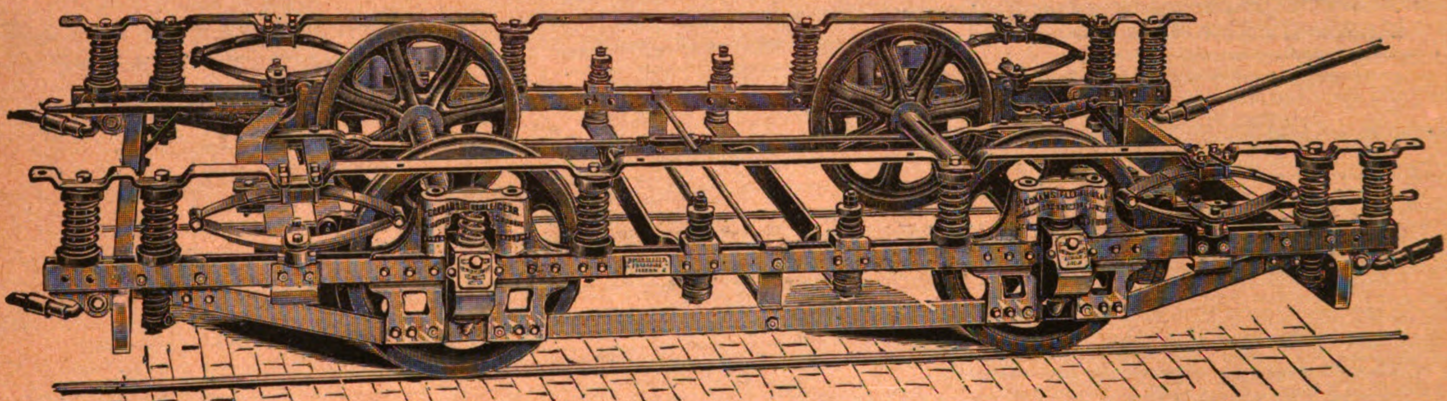

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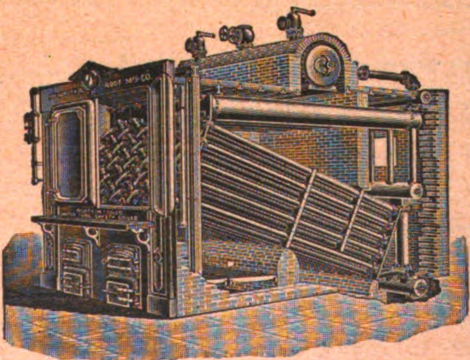

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